UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

JUL 27 2009

In response refer to:
2009/01998

Francis C. Piccola
Chief, Planning Division
U.S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Piccola:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) addendum (Enclosure 1) to the programmatic biological opinion (reference # 2007/07158) for the remaining 24,000 linear feet of authority under Phase II of the Sacramento River Bank Protection Project (SRBPP) based on our review of U.S. Army Corps of Engineers (Corps) Draft Environmental Assessment/Initial Study for Levee Repair of 25 erosion sites under the authority of the SRBPP, Phase II. This addendum analyzes the effects of the project on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), the threatened Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*) and their designated or proposed critical habitat in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

The programmatic biological opinion concluded that the construction of the remaining projects under Phase II of the SRBPP is not likely to jeopardize the above species or adversely modify designated critical habitat, but did not analyze the effects of any specific projects proposed for implementation by the Corps, and anticipated that NMFS would append the programmatic biological opinion with separate project-level analyses and incidental take statements for specific actions carried out under Phase II of the SRBPP, as necessary. Additionally, critical habitat for North American green sturgeon was proposed on September 8, 2008, following the issuance of the programmatic biological opinion, and project-related effects to this proposed critical habitat will be analyzed in this addendum.

Your request for formal consultation was received on April 17, 2009. In this request, the Corps and the Central Valley Flood Protection Board proposed to implement bank protection measures at 13 priority erosion sites in Sacramento, Colusa, and Sutter counties. However, during the May 21, 2009, Interagency Work Group meeting, the Corps stated that one of the proposed sites (Sacramento River, River Mile 78.8) will be removed from the proposed project list for this consultation.

In general, the levee work would involve placement of quarry stone and soil-filled quarry stone on the levee bank slope, construction of vegetated benches, installation of instream woody material, maximum retention of existing trees, and revegetation of the benches and levee slope with native riparian plant species. All of which would entail integrating fish habitat design features over nearly 10,000 linear feet of river bank throughout the Sacramento River Flood Control Project. Four bank repair designs will be implemented, depending on river region, and site-specific erosion and hydraulic conditions. The bank protection projects will repair bank and levee erosion and will replace and restore the riparian and shaded riverine aquatic habitat. All of the proposed project designs are consistent with the design considerations and construction periods analyzed in the programmatic biological opinion.

Based on the best available scientific and commercial information, the draft Environmental Assessment/Initial Study, and our review of the programmatic biological opinion, the implementation of the 12 levee repair sites are not likely to jeopardize the above species or adversely modify designated or proposed critical habitat. NMFS has included an incidental take statement and reasonable and prudent measures with non-discretionary terms and conditions that are project-specific.

Also enclosed are Essential Fish Habitat (EFH) Conservation Recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management (MSA) as amended (16 U.S.C. 1801 *et seq.;* Enclosure 2). This document concludes that the 12 levee repair sites will adversely affect the EFH of Pacific Salmon in the action area and includes recommended measures that, if implemented, will minimize or avoid these adverse effects.

Section 305(b)4(B) of the MSA requires that the Corps provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH Conservation Recommendations, including a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH [(50 CFR ' 600.920(j)]. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

If you have any questions regarding this correspondence please contact Madelyn Martinez in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Ms. Martinez may be reached by telephone at (916) 930-3608 or by Fax at (916) 930-3629.

Sincerely,

Russell M Strach

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file: 151422SWR2009SA00195
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Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY:	United States Army Corps of Engineers (Corps) Sacramento District
ACTIVITY:	Addendum to the Programmatic Consultation for 12 Repair sites of the remaining 24,000 liner feet of Phase II of the Sacramento River Bank Protection Project
CONSULTATION CONDUCTED BY:	NOAA's National Marine Fisheries Service, Southwest Region
FILE NUMBER:	151422SWR2009SA00195
DATE ISSUED:	July 27, 2009

I. CONSULTATION HISTORY

On November 2, 2007, NMFS received the Corps October 24, 2007 request for a programmatic formal consultation for the remainder of Phase II of the Sacramento River Bank Protection Project (SRBPP). The request included the final, October 2007, biological assessment, prepared by Stillwater Sciences.

On July 2, 2008, NMFS issued the Programmatic Biological Opinion for the remaining 24,000 linear feet (lf) of authority under the SRBPP, Phase II (programmatic biological opinion).

On May 7, 2008 NMFS received the Corps' request for formal consultation for the repair of 13 levee erosion sites, totaling approximately 8,000 lf within the Sacramento River Flood Control Project. The request included the draft Environmental Assessment (EA)/Initial Study (IS), a biological assessment and the Standard Assessment Methodology (SAM) analysis for all sites.

On August 27, 28, September 10, and 11, 2008 NMFS participated on a tour of levee repair sites with the Corps, U.S. Fish and Wildlife Service (FWS), California Department of Water Resources (DWR), California Department of Fish and Game (DFG), and their consultants.

On January 22, 23, 27, and March 24, 2009, NMFS participated in meetings that discussed the levee designs and provided our comments regarding the proposed levee repair designs.

On April 17, 2009, NMFS received the Corps April 16, 2009 request for formal consultation for 13 repair sites under the remaining 24,000 linear feet of Phase II of the SRBPP. The request included the draft EA/IS, prepared by Northstate Resources and Stillwater Sciences.

On April 20, 2009, NMFS received the Corps letter clarifying changes in the conceptual design plans in the draft EA/Initial Study.

On May 5, 2009, the Corps published a public notice, *Corps Points,* distributed by Corps Headquarters (HQ), regarding vegetation standards for flood damage reduction infrastructure. The notice clearly and specifically points-out that the contents and criteria discussed in the Engineering Technical Letter (ETL) No. 1110-2-571 *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structure*s are mandatory and should be incorporated into all levee repairs. The contents in the *Corps Points* sends out conflicting messages between the ETL and the proposed action for SRBPP as well as the Central Valley Framework document which Corps HQ and District staff and other state and federal agencies developed as an interim agreement to the Corps *Vegetation on Levees Policy.*

On the May 21, 2009, NMFS brought up the above issue in the Interagency Working Group Committee Meeting. NMFS requested clarification whether the proposed design and the maintenance for the 13 repair sites would follow the ETL or implement the designs and maintain the sites to meet the Standard Assessment Methodology (SAM) values for year 3, 5, 10, 25, and 50 as was described in the biological assessment for the project. We also requested a detailed explanation and reason why the proposed action is exempt from the ETL.

On May 21, 2009, the Corps stated that one of the 13 repair sites will be removed form the consultation package. The repair site is Sacramento River, River Mile 78.8 and is interrelated to another project, Natomas Levee Improvement Project. Thus, NMFS received their request of Standard Assessment Method (SAM) analyses specific for the 12 repair sites.

On June 12, 2009, NMFS received a letter from the Corps stating that the Corps' ETL 1110-2-571 has been reviewed and determined to have no effect on the proposed 2009 bank protection work. The Corps and Central Valley Flood Protection Board plans to implement the design features described in the May 2009 Final EA/EIS. In addition, the letter stated that the Crops will ensure that the future maintenance actions for the life of the project will meet performance criteria necessary to retain the SAM-modeled habitat values.

On June 19, 2009, NMFS received a June 12, 2009, letter from the Corps, stating that the Corps plans to increase the Instream Woody Material (IWM) percent shoreline cover for certain repairs sites to compensate for negative values in the SAM modeling results. These increases would result in Sacramento River (SAC) , river mile 35.4, left bank (L) and Feather River (FR) 7.0L changing from 40 percent shoreline coverage to 80 percent, while SAC 73.5L, SAC 87.0L, SAC 93.7L, SAC 114.5 right bank (R), Sac 136.7R, SAC 136.9R, and FR 5.5L would change from 50 percent shoreline coverage to 100 percent.

This addendum to the programmatic biological opinion is based on information provided in the April 2008 draft EA/IS; discussions held with the Corps, USFWS, and CDFG; letters received form the Corps for additional information, field reviews of previous and existing erosion and repair sites; SAM analyses; and engineering designs. A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to construct a total of twelve levee repair projects within the Sacramento River Flood Control Project (SRFCP) under the authority of the SRBPP. The vicinity of the SRBPP project area is shown in Figure 1, and Figure 2 illustrates the locations of each of the repair sites. The work would be conducted in 2009 and 2010 following the construction periods and methodologies described in the 2008 programmatic biological opinion. The bank protection projects will repair bank and levee erosion and will replace and restore the riparian and shaded riverine aquatic habitat. In general, the work will involve placing rock revetment along approximately 10,000 linear feet of river bank. Soil fill suitable for plant growth will be mixed in and placed on top of the rock revetment, and the repair sites will be vegetated with riparian trees and shrubs. Instream woody material will be placed along the sites to provide juvenile fish cover. Existing vegetation will be protected to the maximum extent practicable and will only be removed or trimmed if necessary to construct project features.

The project designs are slightly modified from the main design alternatives that are described and analyzed in the programmatic biological opinion, but retain the fish habitat features (*i.e.*, IWM, mixture of soil fill and riprap, riparian bench, etc.). For reference, these designs are illustrated in Figure 4 through 7. The first three designs were modified from the programmatic biological opinion designs to accommodate specific repair site conditions. Only one design from the programmatic biological opinion will not be constructed (*i.e.*, design 4, Figure 4). This design, which creates wetlands that are commonly found close to the Delta, was not selected for construction because the 12 repair sites are well upstream of the Delta, above RM 30.

Since the publication of the May 5, 2009, *Corps Points* document regarding vegetation standards for flood damage reduction infrastructure, NMFS has been concerned about potential effects to the riparian vegetation component of the proposed project. As an assurance, the Corps has reviewed the ETL and determined that it will have no effect on the proposed 2009 bank protection work. The Corps and Central Valley Flood Protection Board still plans to implement the proposed vegetative design features and ensure that the future maintenance actions for the life of the project will meet performance criteria necessary to retain the SAM-modeled habitat values.

For the purposes of the programmatic biological opinion and this addendum, the SRBPP action area has been divided into four regions, organized south to north. The regions are 1a, 1b, 2, and 3. Project locations, regions, sizes and important fish habitat considerations are summarized in Table 1. The regions are illustrated in Figure 3.

A. Site-specific project descriptions

The repairs will be conducted under three separate contracts. DWR will oversee one contract for projects repairs at SAC 35.4 L, FR 7.0L, the Lower American River (LAR) at 10.0L, and LAR 10.6L. The Corps will oversee the other two contracts for construction at, SAC 73.5L, SAC 87.0L, and FR 5.5L, SAC 93.7L, SAC 114.5R, SAC 136.7 right bank (R), SAC 136.9R, and Sutter Bypass 0.4 east side (E). All levee repair sites were selected based on a comprehensive erosion site evaluation prepared by Ayres and Associates (2005, 2006). The evaluations are made based on field surveys and quantitative ranking of characteristics, such as bank slope, bench width, length and location of erosion, radius of curvature, bank stability, dynamic geomorphology, vegetation cover, tree hazards, soil type, water velocity, wave action, economic factors, human use, seepage potential, and tidal fluctuation.

B. Construction staging, sequencing, and equipment

The project will be constructed following schedules and procedures that are described in the programmatic biological opinion. In general, revetment will be placed from cranes mounted on barges or from adjacent landside areas. Waterside construction will occur where it minimizes noise and traffic disturbances, and effects on existing vegetation. The contractor will use adjacent landside areas for staging of vehicles, plant materials, and other associated construction equipment, as necessary. Protective fencing will be installed to prevent vehicles from approaching the waterside edge of the existing bank.

For construction at sites downstream of RM 60 on the Sacramento River, including sloughs, all in-water construction will occur between August 1 and November 30 unless approved otherwise by NMFS. For sites within all other parts of the SRBPP action area, in-water construction will occur between July 1 and November 30, of each year unless directed otherwise by NMFS. Conducting in-water construction during these low flow periods will help minimize water quality impacts and will avoid sensitive rearing and spawning periods for salmonid species and delta smelt. Construction or planting activities that do not have potential water quality impacts may be conducted year-round.

C. Operations and Maintenance

Once repairs are complete, a project site may require limited maintenance. Operations and Maintenance details are described in the programmatic biological opinion.

D. Proposed Minimization and Conservation Measures

The Corps will implement minimization and conservation measures, including best management practices (BMPs) to reduce construction-related impacts. Additional conservation measures will be taken to offset the temporal and spatial impacts of levee repair sites as described in the programmatic biological opinion. These may include off-site conservation such as setback levees, levee breaching and flooding of delta islands, construction of in-channel and off-channel wetland benches, planting riparian trees, installation of in-stream wood, or the purchase of credits at suitable conservation banks. Since the repair sites LAR 10.0L and 10.6L would impact 0.6 acres of spawning habitat, DWR plans to contribute towards US Bureau of Reclamation's Spawning Gravel Augmentation project at a 2:1 ratio (total = 1.19 acres) to compensate adequately for the potential spatial and temporal loss of spawning habitat and conduct a 3-year monitoring study of the spawning gravel to evaluate whether additional credits need to be purchased.

E. Monitoring plan

The Corps has prepared a detailed monitoring plan that includes: (1) monitoring methods, performance standards for SAM variables, and success criteria for riparian vegetation and SRA cover; and (2) a protocol for implementing remedial actions should any success criteria not be met. The monitoring plan shall be incorporated into an Operations and Maintenance (O&M) manual for the project sites. A monitoring report that evaluates how the site meets the conservation success criteria will be submitted to the resource agencies by December of each year. Monitoring will be conducted until the success of conservation actions are either substantially confirmed or discounted.

To ensure that on-site and off-site habitat features are functioning as designed to specifically benefit Federally protected fish species, fishery monitoring efforts will be reported separately from the monitoring efforts described above. An initial salmon and steelhead monitoring effort is currently ongoing and will continue through at least 2012 to determine the effects of bank protection installed between 2001 and 2006 on listed species. Yearly adjustments and expansion of the fisheries monitoring plan to include new repair sites will be made through the Interagency Work Group (IWG); the Corps will submit a draft monitoring plan to NMFS by November 30 of each year. A draft monitoring report will be submitted to NMFS by December 30 of each year.

On May 5, 2009, the Corps submitted a green sturgeon monitoring plan to comply with Term and Condition 1.k of the programmatic biological opinion. The monitoring plan will conduct studies to address population trends, movements, habitat requirements, and detailed modeling efforts of green sturgeon in the Sacramento River Basin. The study will be conducted by the Corps' Engineer Research and Development Center (ERDC) and UC Davis scientists. The study includes (1) capturing and tagging green and white sturgeon with remote sonic receivers (VR2) and (2) installing videography and dual frequency identification SONAR (DIDSON) in locations where sturgeon congregate. Approximately 40 green sturgeon will be captured during August and September to place a Vemco V16-H acoustic tags. During tagging operations, data will be collected on size, gender, and reproductive status of each fish, and a sample of their pectoral ray will be taken for age determination. During videography and SONAR surveys, sturgeon habitat will be mapped at representative sites using GIS and correlations between habitat features and abundance of sturgeon quantified. Data will be used in combination with data from the first task to develop running estimates of population size.

F. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area for the overall SRBPP programmatic consultation extends south-to-north along the Sacramento River from the town of Collinsville, at river mile (RM) 0 upstream to Chico at RM 194, and includes reaches of lower Elder and Deer creeks. The SRBPP also includes Cache Creek, the lower reaches of the American River (RM 0–23), Feather River (RM 0–61), Yuba River (RM 0–11), and Bear River (RM 0–17), as well as portions of Threemile, Steamboat, Sutter, Miner, Georgiana, and Cache sloughs.

The action area for the proposed action analyzed in this addendum extends from Sacramento RM 137.0 downstream to Sacramento River RM 35.0, and includes Feather River RM 5.5L and 7.0L, American River RM 10.0L and 10.6L, and Sutter Bypass 0.4E.

For the purposes of the programmatic biological opinion and this addendum, the SRBPP action area has been divided into four regions, organized south to north by the location of the downstream terminus of each watercourse with the mainstem Sacramento River. These four regions represent biologically similar habitat functions. The regions are 1a, 1b, 2, and 3. The water bodies within these regions are illustrated in Figure 3.

Table 1. Summary of the 12 repair sites on their location, responsible agency, length, type of design, and percent IWM to be replaced.

Programmatic Region	**Waterbody**	**Site**	**Agency**	**Construction Contract (year)**	**Approximate Site Length (feet)1**	**Site Length in Summer for use in the SAM (feet)1**	**IWM Removed (linear feet)**	**IWM Replaced (linear feet)**	**Landscaping**	**General Project Design**
1b	Sacramento River (RM 20-80)	SAC 35.4L	DWR	DWR 2009	1,070	1,078	0	862.4	Unrestricted	Undulating Riparian Bench
		SAC 73.5L	Corps	1 (2009)	1,050	1,066	331	1066	Unrestricted	Flat Riparian Bench
2	Sacramento River (RM 80-143)	SAC 87.0L	Corps	1 (2009)	750	762	15	762	Unrestricted	Flat Riparian Bench
		SAC 93.7L	Corps	2 (2009)	1,050	910	6	910	Unrestricted	Flat Riparian Bench
		SAC 114.5R	Corps	2 (2009)	1,500	1,525	457	1525	Unrestricted	Flat Riparian Bench
		SAC 136.7R	Crops	2 (2009)	300	307	2	307	Unrestricted	Flat Riparian Bench
		SAC 136.9R	Corps	2 (2009)	900	875	38	875	Unrestricted	Flat Riparian Bench
	Feather River	FR 5.5L	Corps	1 (2009)	832	841	235	841	Unrestricted	Sloping Riparian Bench
		FR 7.0L	DWR	DWR (2009)	520	594	8	475.2	Unrestricted	Undulating Riparian Bench
1b	Lower American River	LAR 10.0L	DWR	DWR (2009)	740	757	70	302.8	Unrestricted	Undulating Riparian Bench
		LAR 10.6L	DWR	DWR (2009)	670	690	187.5	276	Unrestricted	Undulating Riparian Bench
2	Sutter Bypass	SBP 0.4E	Corps	2 (2009)	365	366	28	91.5	Unrestricted	Flat Riparian Bench
					9,747	9,771	1,377.50	8,293.90		

Figure 1. Vicinity map of the SRBPP action area.

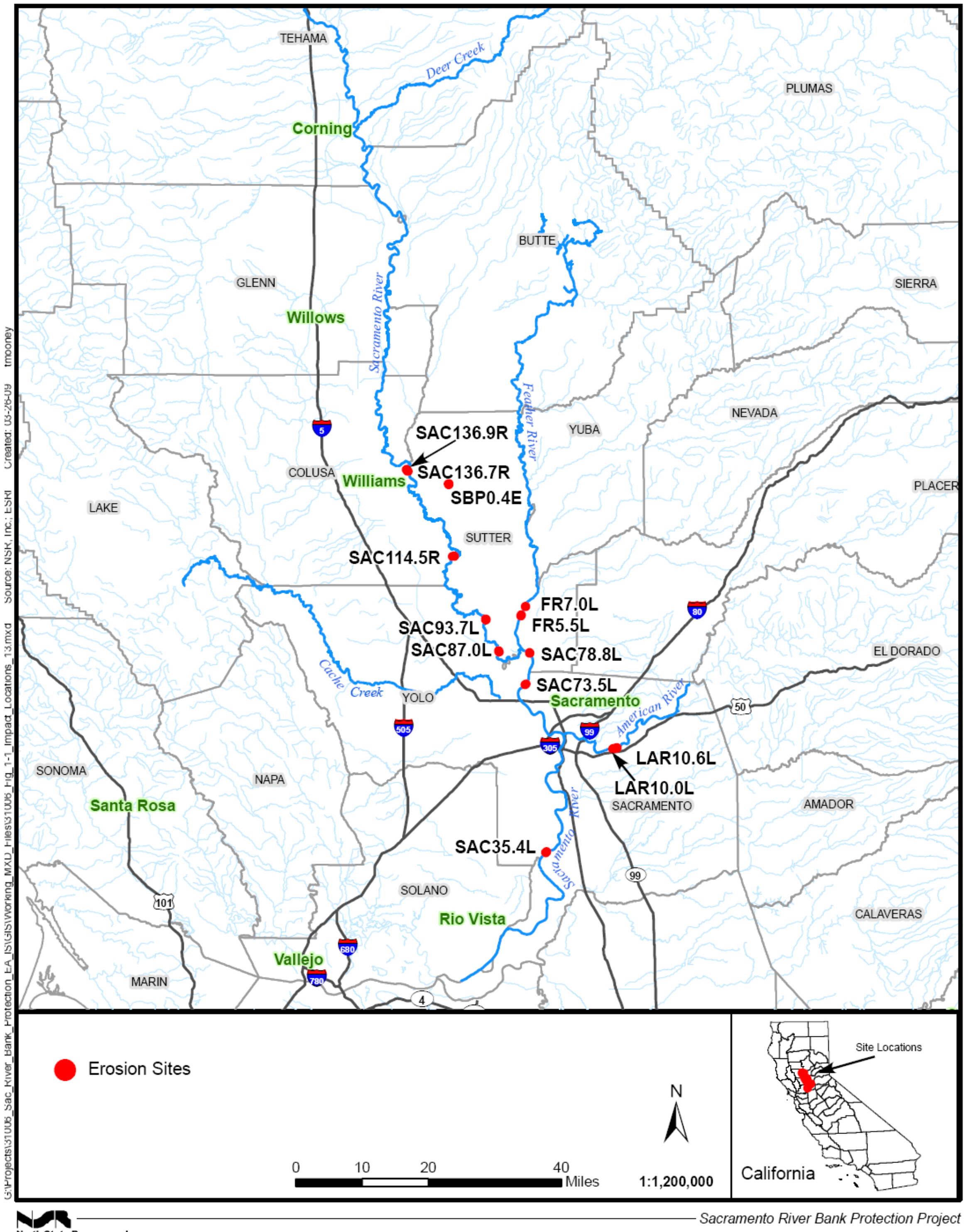

Figure 2. Identified erosion sites within the SRBPP planning area.

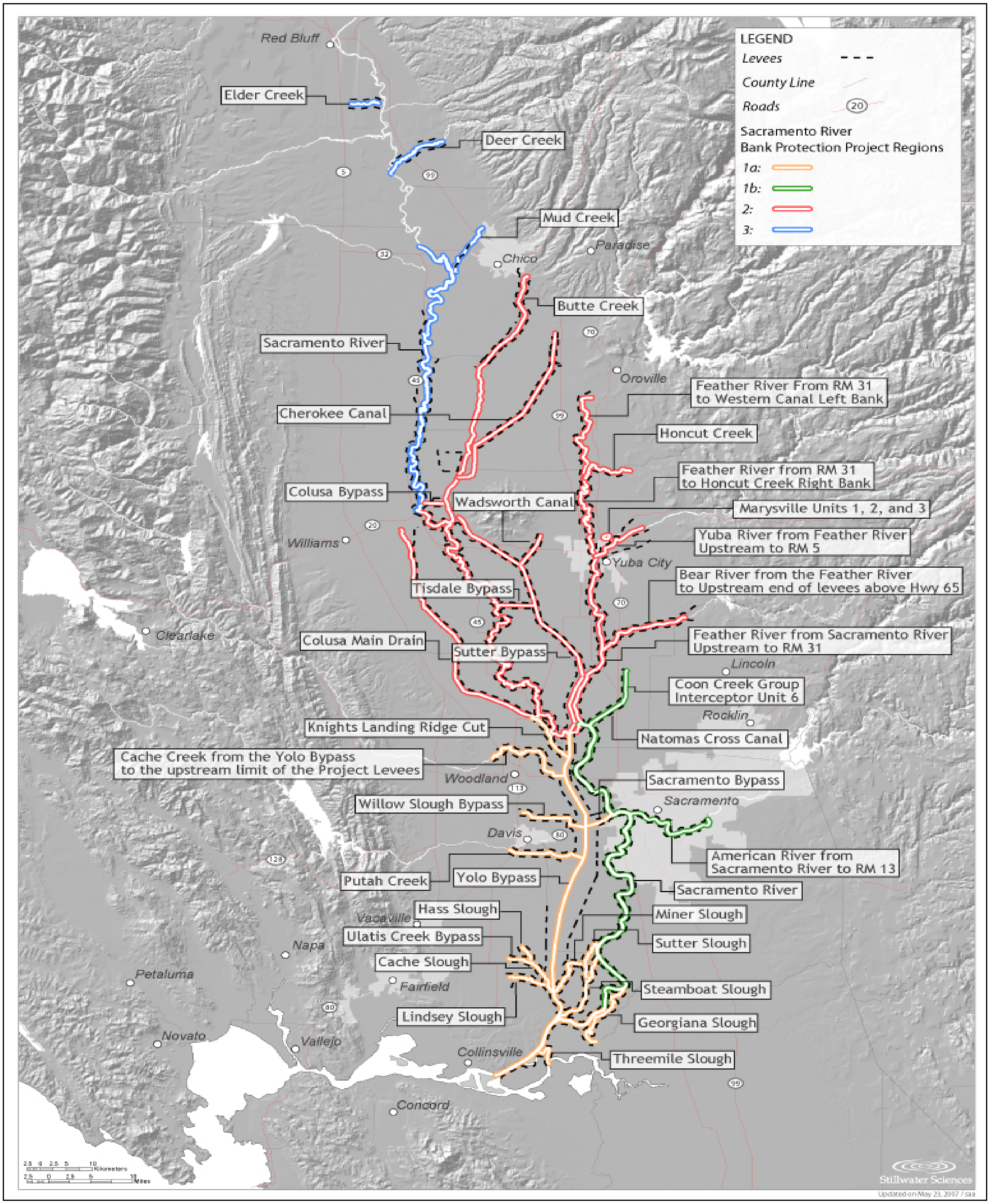

Figure 3. Subregions designated for the SRBPP action area.

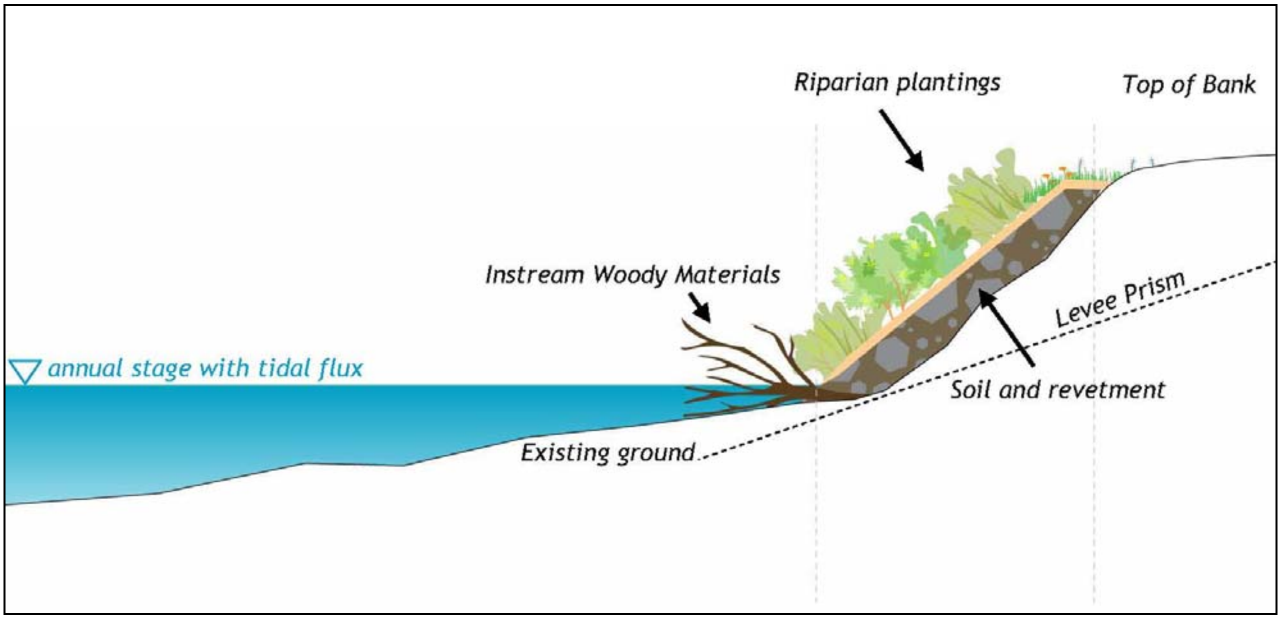

Figure 4. Design 1 – Bank fill rock slope with IWM above and below MSWL

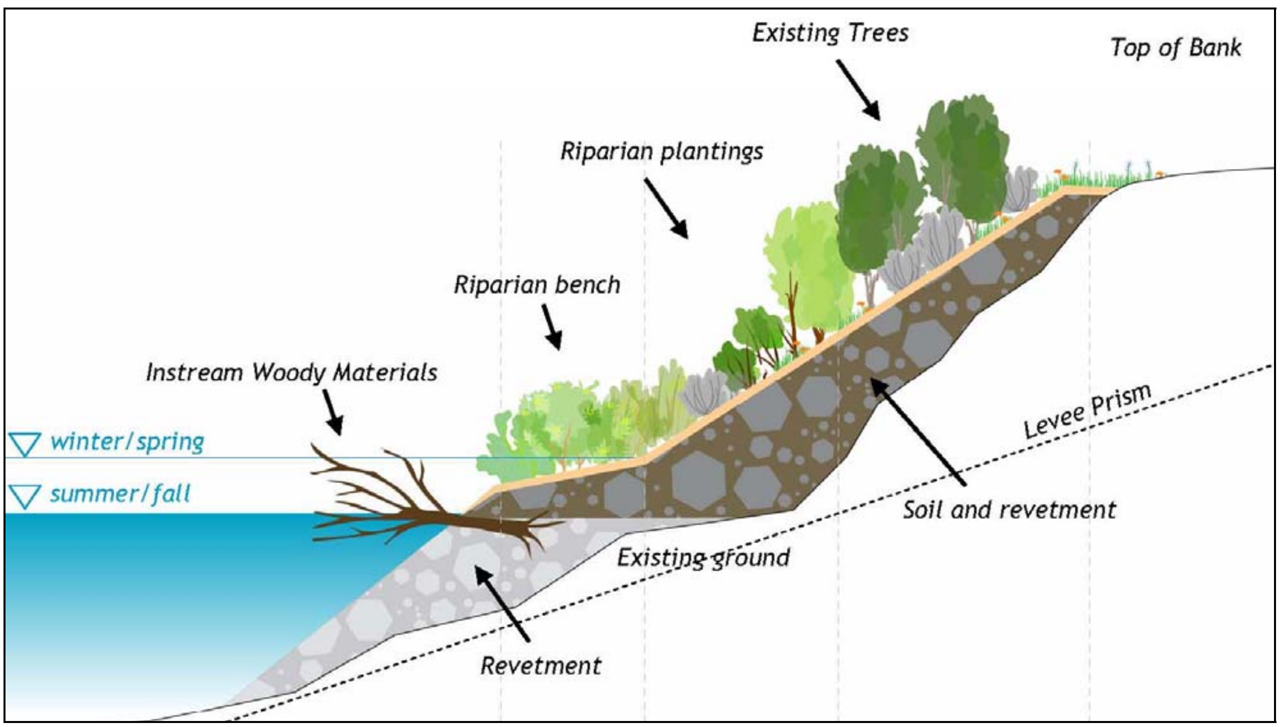

Figure 5. Design 2 – Low riparian bench with IWM above and below MSWL.

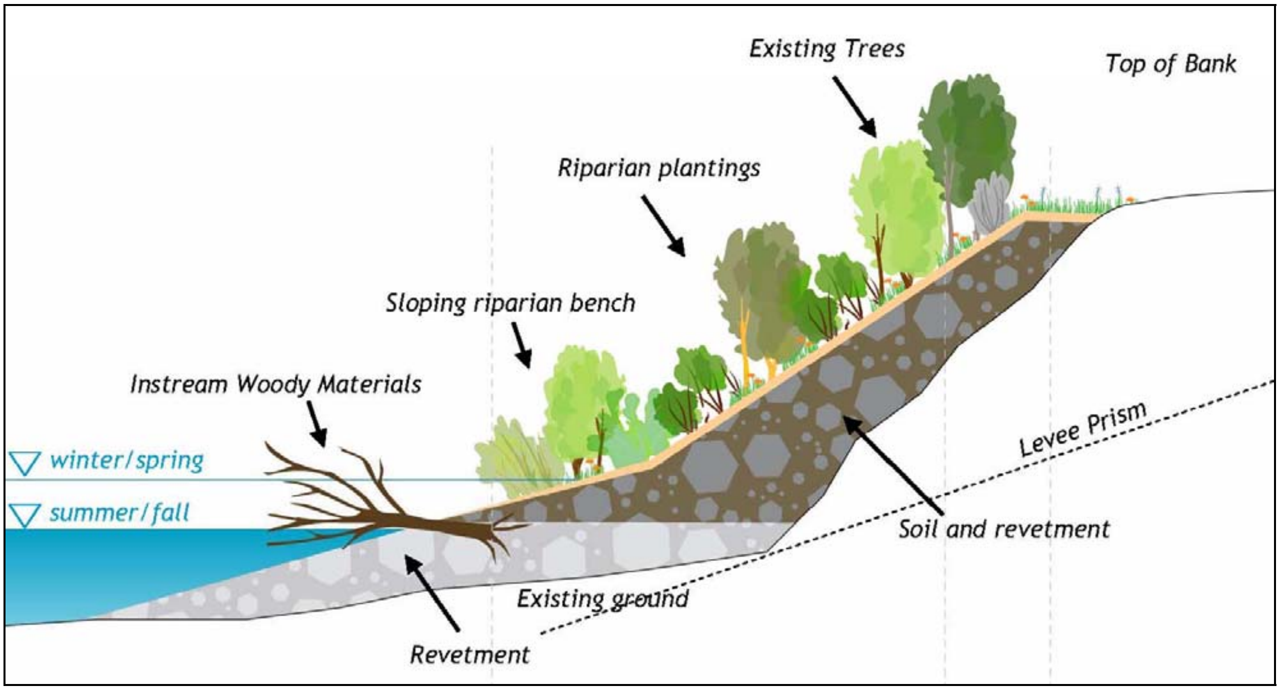

Figure 6. Design 3 – Sloping riparian bench with above and below MSWL.

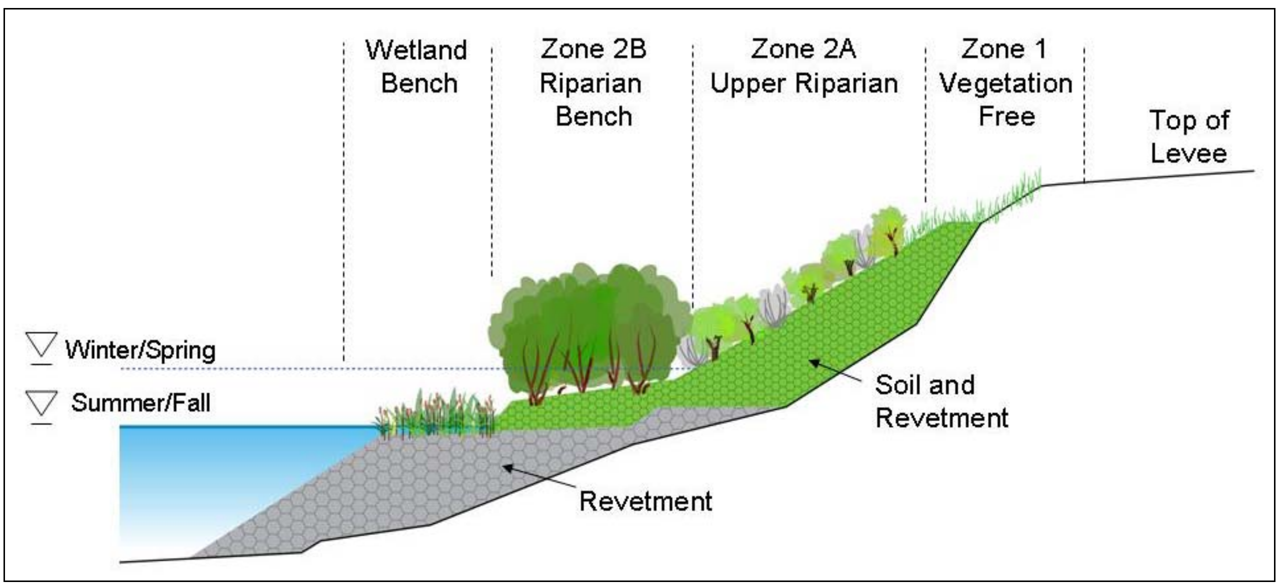

Figure 7. Design 4: Delta smelt design – Low riparian and wetland benches with revegetation downstream of RM 30.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species evolutionary significant units (ESU) or distinct population segments (DPS) and designated critical habitat occur in the action area and may be affected by the proposed project:

Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
endangered (June 28, 2005, 70 FR 37160)
Sacramento River winter-run Chinook salmon designated critical habitat
(June 16, 1993, 58 FR 33212)
Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)
threatened (June 28, 2005, 70 FR 37160)
Central Valley spring-run Chinook salmon designated critical habitat
(September 2, 2005, 70 FR 52488)
Central Valley steelhead DPS (*Oncorhynchus mykiss*)
threatened (December 22, 2005)
Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)
Southern DPS of North American green sturgeon (*Acipenser medirostris*)
threatened (April 7, 2006, 70 FR 17386)
Southern DPS of North American green sturgeon proposed critical habitat
(Proposed September 8, 2008, 73 FR 52084)

The programmatic biological opinion includes a detailed S*tatus of the Species and Critical Habitat* section, describing the life history, population dynamics, migration timing, habitat use, and viability of the species listed above, and the conservation condition of their designated critical habitat. This addendum summarizes the key findings of the programmatic biological opinion and also describes the critical habitat for North American Green sturgeon, which was proposed in April 2008 and not previously described.

The viability of Central Valley salmonids was summarized by Lindley *et al*. (2006), who found that extant populations of Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon appear to be fairly viable. These populations meet several viability criteria including population size, growth, and risk from hatchery strays. The viability of the overall ESUs to which these populations belong appears low to moderate, because the ESUs remain vulnerable to extirpation due to their small-scale distribution and high likelihood of being affected by a significant catastrophic event. Lindley *et al*. were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extirpation since most of the historic habitat is inaccessible due to dams, and because the anadromous life-history strategy is being replaced by residency. McEwan (2001) concluded that the DPS faces a moderate to high risk of extinction due to negative adult population trends and the reduced geographic distribution related to the loss of spawning habitat behind dams (McEwan 2001).

Recent habitat evaluations conducted in the upper Sacramento River for salmonid recovery planning (Lindley *et al*. 2007) suggests that significant potential green sturgeon spawning habitat was made inaccessible or altered by dams (historical habitat characteristics, temperatures, and geology summarized). This spawning habitat may have extended into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). Due to substantial habitat loss as well as existing threats to the Southern DPS of North American green sturgeon, it remains at a moderate to high risk of extinction.

The NMFS Critical Habitat Assessment and Review Team (CHART) (CHART, 2005) reviewed the status of currently occupied habitat and areas under consideration to be designated as critical habitat based, in part, on the quality, and conservation value of the habitat to listed salmonids in the Central Valley. The CHART report also considered the need for special management considerations in order to maintain the conservation value of the habitat for listed species. According the CHART report, the current function of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in conservation condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin river reaches tended to range from poor to high quality, depending on location. The alluvial reach of the Sacramento River between Red Bluff and Colusa is in good condition because, despite the influence of upstream dams, this reach retains naturally functioning channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is in poor condition due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

A. Proposed Critical Habitat for North American Green Sturgeon

Critical habitat was proposed for Southern DPS of green sturgeon on September 8, 2008 (73 FR 52084). Proposed critical habitat for Southern DPS of green sturgeon includes approximately 325 miles of riverine habitat and 1,058 square miles of estuarine habitat in California, Oregon, and Washington, and 11,927 square miles of coastal marine habitat off California, Oregon, and Washington within the geographical area presently occupied by the Southern DPS of green sturgeon. In addition, approximately 136 square miles of habitat within the Yolo and Sutter bypasses, adjacent to the Sacramento River, California, are proposed for designation. Figure 8 illustrates inland and marine habitats that are proposed for designation.

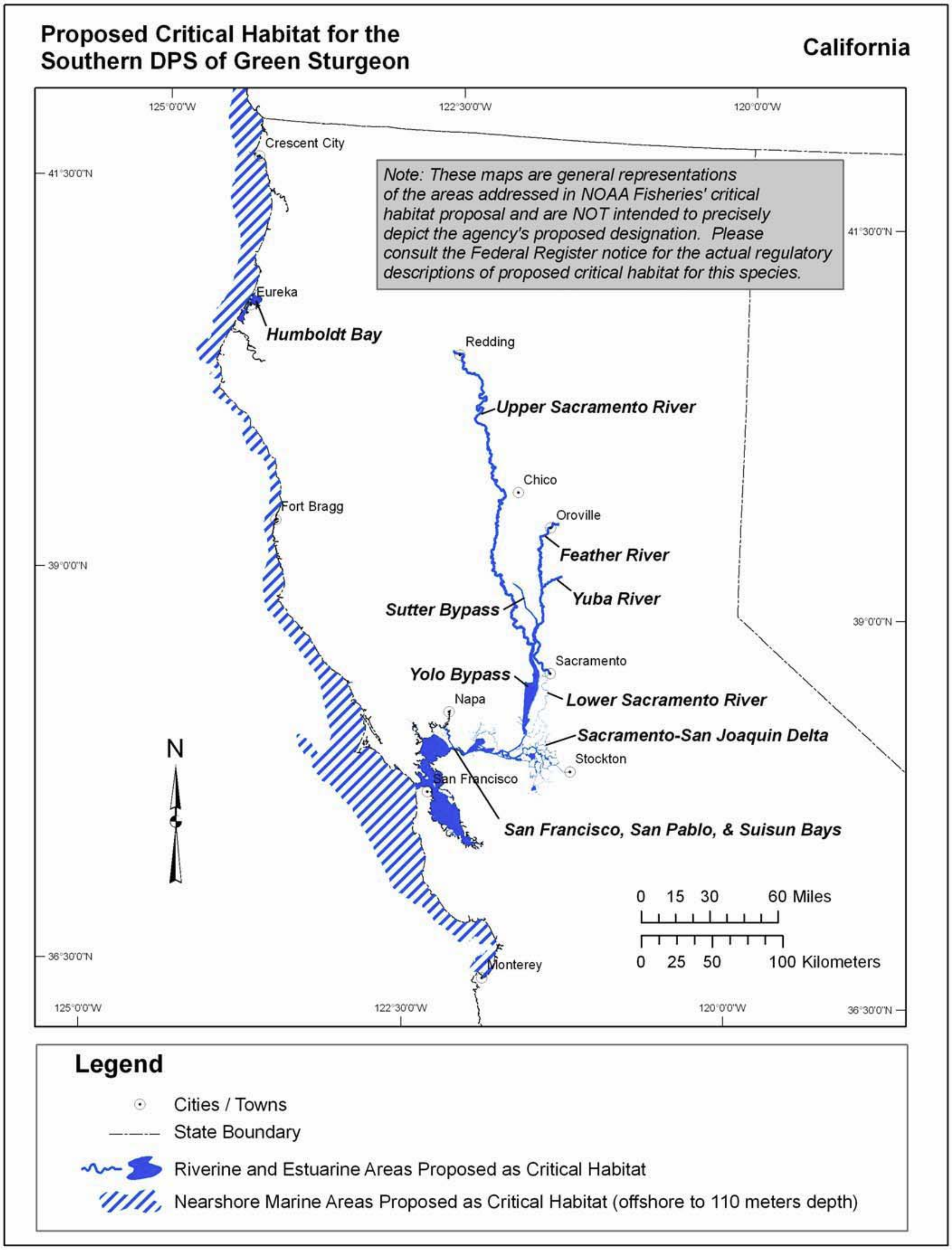

Figure 8. Proposed critical habitat for the Southern DPS of green sturgeon including inland and marine areas

B. Proposed Critical Habitat and Primary Constituent Elements for North American Green Sturgeon

The proposed critical habitat for North American Green Sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. Primary constituent elements for green sturgeon have been proposed for freshwater riverine systems, estuarine habitats, and nearshore coastal areas.

Freshwater Riverine Systems

Food Resources - Abundant food items for larval, juvenile, subadult, and adult life stages should be present in sufficient amounts to sustain growth (larvae, juveniles, and subadults) or support basic metabolism (adults). Although we lack specific data on food resources for green sturgeon within freshwater riverine systems, nutritional studies on white sturgeon suggest that juvenile green sturgeon most likely feed on macro benthic invertebrates, which can include plecoptera (stoneflies), ephemeroptera (mayflies), trichoptera (caddis flies), chironomid (dipteran fly larvae), oligochaetes (tubifex worms) or decapods (crayfish). These food resources are important for juvenile foraging, growth, and development during their downstream migration to the Delta and bays. In addition, subadult and adult green sturgeon may forage during their downstream post-spawning migration or on non-spawning migrations within freshwater rivers. Subadult and adult green sturgeon in freshwater rivers most likely feed on benthic invertebrates similar to those fed on in bays and estuaries, including freshwater shrimp and amphipods. Many of these different invertebrate groups are endemic to and readily available in the Sacramento River from Keswick Dam downstream to the Delta. Heavy hatches of mayflies, caddis flies, and chironomids occur in the upper Sacramento River, indicating that these groups of invertebrates are present in the river system. NMFS anticipates that the aquatic life stages of these insects (nymphs, larvae) would provide adequate nutritional resources for juvenile green sturgeon rearing in the river.

Substrate Type or Size - Suitable critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to "collect" eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adult life stages (*e.g.*, substrates for holding and spawning). For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.*, 1991, Moyle *et al.* 1995). Eggs likely adhere to substrates, or settle into crevices between substrates (Deng 2000, Van Eenennaam *et al.* 2001, and Deng *et al.* 2002). Both embryos and larvae exhibited a strong affinity for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2007). Recent stream surveys by USFWS and Reclamation biologists have identified approximately 54 suitable holes and pools between Keswick Dam and approximately GCID that would support spawning or holding activities for green sturgeon based on the identified physical criteria. Many of these locations are at the confluence of tributaries with the mainstem Sacramento River or at bend pools. Observations of channel type and substrate compositions during these surveys indicate that appropriate substrate is available in the Sacramento River between GCID and Keswick Dam. Ongoing surveys are anticipated to further identify river reaches with suitable substrate characteristics in the upper river and their utilization by green sturgeon.

Water Flow - An adequate flow regime (*i.e*., magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 - 19°C) (Cech *et al.* 2000, Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning success is most certainly associated with water flow and water temperature compared to other variables. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown 2007). Post-spawning downstream migrations are triggered by increased flows, ranging from 6,150 – 14,725 cfs in the late summer (Vogel 2005) and greater than 3,550 cfs in the winter (Erickson *et al.* 2002; Benson *et al.* 2007). The current suitability of these flow requirements is almost entirely dependent on releases from Shasta Dam. High winter flows associated with the natural hydrograph do not occur within the section of the river utilized by green sturgeon with the frequency and duration that was seen in pre-dam conditions. Continued operations of Shasta Dam and the CVP are likely to further attenuate these high flow events. Rearrangement of the river channel and the formation of new pools and holes are unlikely to occur given the management of the river's discharge to prevent flooding downstream of Shasta Dam.

Water Quality - Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages are required for the properly functioning of the freshwater habitat. Suitable water temperatures would include: stable water temperatures within spawning reaches (wide fluctuations could increase egg mortality or deformities in developing embryos); temperatures within 11 - 17°C (optimal range = 14 - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Due to the temperature management of the releases from Keswick Dam for winter-run in the upper Sacramento River, water temperatures in the river reaches utilized currently by green sturgeon appear to be suitable for proper egg development and larval and juvenile rearing. Suitable salinity levels range from fresh water (< 3 ppt) for larvae and early juveniles [about 100 days post hatch (dph)] to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Salinity levels are suitable for green sturgeon in the Sacramento River and freshwater portions of the Delta for early life history stages. Adequate levels of DO are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles, Allen and Cech 2007). Current mainstem DO levels are suitable to support the growth and migration of green sturgeon in the Sacramento River. Suitable water quality would also include water free of contaminants (*i.e*., pesticides, organochlorines, elevated levels of heavy metals, *etc*.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Water free of such contaminants would protect green sturgeon from adverse impacts on growth, reproductive development, and reproductive success (*e.g*., reduced egg size and abnormal gonadal development, abnormal embryo development during early cleavage stages and organogenesis) likely to result from exposure to contaminants (Fairey *et al.* 1997, Foster *et al.* 2001a, Foster *et al.* 2001b, Kruse and Scarnecchia 2002, Feist *et al.* 2005, and Greenfield *et al.* 2005). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin.

Migratory Corridor - Safe and unobstructed migratory pathways are necessary for passage within riverine habitats and between riverine and estuarine habitats (*e.g*., an unobstructed river or dammed river that still allows for passage). Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning/rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

Green sturgeon adults that migrate upstream in April, May, and June are completely blocked by the ACID diversion dam. Therefore, 5 miles of spawning habitat are inaccessible upstream of the diversion dam. It is unknown if spawning is occurring in this area. Adults that pass upstream of ACID dam before April are forced to wait 6 months until the stop logs are pulled before returning downstream to the ocean. Upstream blockage forces sturgeon to spawn in approximately 12 percent less habitat between Keswick Dam and RBDD. Newly emerged green sturgeon larvae that hatch upstream of the ACID diversion dam would be forced to hold for 6 months upstream of the dam or pass over it and be subjected to higher velocities and turbulent flow below the dam, thus rendering the larvae and juvenile green sturgeon more susceptible to predation.

Closure of the gates at RBDD from May 15 through September 15 precludes all access to spawning grounds above the dam during that time period. Adult green sturgeon that cannot migrate upstream past the RBDD either spawn in what is believed to be less suitable habitat downstream of the RBDD (potentially resulting in lower reproductive success) or migrate downstream without spawning, both of which would reduce the overall reproductive success of the species.

Adult green sturgeon that are successful in passing the RBDD prior to its closure have to negotiate the dam on their subsequent downstream migration following spawning during the gates down period. Recent acoustic tag data indicates that some fish are successful in passing the dam when the gates are in the “closed” position. Typically the gates are raised slightly from the bottom to allow water to flow underneath the radial gates and fish apparently can pass beneath the radial gates during this period. However, recent observed mortalities of green sturgeon during an emergency gate operation (2007) indicate that passage is not without risk if the clearance is too narrow for successful passage.

Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in May, June, and July, during the RBDD gates down period. Juvenile green sturgeon would likely be subjected to the same predation and turbulence stressors caused by RBDD as the juvenile anadromous salmonids, leading to diminished survival through the structure and waters immediately downstream.

Depth - Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River above GCID. The significance and purpose of these aggregations are unknown at the present time, although it is likely that they are the result of an intrinsic behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). As described above approximately 54 pools with adequate depth have been identified in the Sacramento River above the GCID location.

Sediment Quality - Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), PAHs, and organochlorine pesticides] that can result in negative effects on any life stages of green sturgeon. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern throughout the watershed.

<u>For Estuarine Habitats</u>

Food Resources - Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fish, including crangonid shrimp, callianassid shrimp, burrowing thalassinidean shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source. The recent spread of the Asian overbite clam has shifted the diet profile of white sturgeon to this invasive species. The overbite clam now makes up a substantial proportion of the white sturgeon's diet in the estuary. NMFS assumes that green sturgeon have also altered their diet to include this new food source based on its increased prevalence in the benthic invertebrate community.

Water Flow - Within bays and estuaries adjacent to the Sacramento River (*i.e*., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. Currently, flows provide the necessary attraction to green sturgeon to enter the Sacramento River. Nevertheless, these flows are substantially less than what would have been available historically to stimulate the spawning migration.

Water Quality - Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, adequate levels of DO are also required to support oxygen consumption by juveniles (ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1}, Allen and Cech 2007). Suitable water quality also includes water free of contaminants (*e.g*., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Water quality in the areas such as the Stockton turning basin and Port of Stockton routinely have depletions of DO and episodes of first flush contaminants from the surrounding industrial and urban watershed. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo Bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

Migratory Corridor - Safe and unobstructed migratory pathways are necessary for the safe and timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Rearing fish need the ability to freely migrate from the river through the estuarine waterways of the delta and bays and eventually out into the ocean. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP water projects alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the DCC facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Hydraulic dredging can result in the entrainment of fish into the dredger's hydraulic cutterhead intake. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

Water Depth - A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥ 5 m) holding pools within bays and estuaries as well as within freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia for subadult and adult green sturgeon (Benson *et al*. 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters over shallow depths of less than 10 m, either swimming near the surface or foraging along the bottom (Kelly *et al*. 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 – 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966). Thus, a diversity of depths is important to support different life stages and habitat uses for green sturgeon within estuarine areas.

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are comprised of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. The channels are simplified trapezoidal shapes with little topographical variation along the channel alignment. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin River systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

Sediment Quality - Sediment quality (*i.e*., chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g*., elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *Sediment quality* for riverine habitats above).

For Nearshore Coastal Marine Areas

Migratory Corridor - Safe and unobstructed migratory pathways are necessary for passage within marine coastal zones along the west coast of North America and between estuarine and marine habitats. Subadult and adult green sturgeon spend as much as 13 years out at sea before returning to their natal rivers to spawn. Safe and unobstructed passage within near shore marine waters is critical for subadult and adult green sturgeon to access over-summering habitats within coastal estuaries and over-wintering habitats within coastal estuaries and coastal waters off of Vancouver Island, British Columbia. Passage is also necessary for subadults and adults to migrate back to San Francisco Bay and to the Sacramento River for spawning. Potential conflicts may occur in shipping corridors, areas with commercial bottom trawl fisheries, and coastal discharge of wastewater from sanitation facilities.

Water Quality - Nearshore marine waters should have adequate DO levels and be free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon. Based on studies of tagged subadult and adult green sturgeon in the San Francisco Bay estuary, California, and Willapa Bay, Washington, subadults and adults may need a minimum DO level of at least 6.54 mg O_2/l (Kelly *et al.* 2007, Moser and Lindley 2007). As described above, exposure to and bioaccumulation of contaminants may negatively affect the growth, reproductive development, and reproductive success of subadult and adult green sturgeon. Thus, waters free of such contaminants would benefit the normal development of green sturgeon for optimal survival and spawning success.

Food Resources - Abundant food items for subadults and adults, which may include benthic invertebrates and fish, are important to the growth and viability of subadult and adult green sturgeon. Green sturgeon spend from 3 – 13 years in marine waters, migrating long distances of up to 100 km per day [Biological Review Team (BRT) 2005]. Although most tagged individuals swim at speeds too fast for feeding, some individuals swam at slower speeds and resided in areas over several days, indicating that they may be feeding. Abundant food resources are important to support subadults and adults over long-distance migrations, and may be one of the factors attracting green sturgeon to habitats farther to the north (off the coast of Vancouver Island and Alaska) and to the south (Monterey Bay, California, and off the coast of southern California) of their natal habitat. Although direct evidence is lacking, prey species are likely to include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries (*e.g.*, shrimp, clams, crabs, anchovies, sand lances). Concentrations of these species in the near shore environment are likely to attract congregations of adult and sub-adult green sturgeon.

IV. ENVIRONMENTAL BASELINE

The environmental baseline “includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process” (50 CFR §402.02).

The programmatic biological opinion includes a detail *Environmental Baseline* section, describing the life history, population dynamics, migration timing, habitat use, and viability of the species listed above, and the conservation condition of their designated critical habitat within the action area. This addendum summarizes the key findings of the programmatic biological opinion.

The action area functions as a migratory corridor for adult Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and provides migration and rearing habitat for juveniles of these species. A large proportion of all Federally listed Central Valley salmonids are expected to utilize aquatic habitat within the action area, including the entire population of winter-run Chinook salmon. The action area also functions as a migratory and holding corridor for adult and rearing and migratory habitat for juvenile Southern DPS of North American green sturgeon.

Based on Lindley *et al.*, 2006 viability assessments, the recent habitat improvements that have been occurring throughout the action area, and the emergence of levee repair designs and approaches that minimize fish habitat loss, and incorporate extensive fish habitat features designed for the purpose of improving the amount and quality of rearing habitat, the programmatic biological opinion and this addendum find that Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon are likely to continue to survive and recover in the action area.

The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. Habitat requirements for these species are similar. The PCEs of salmonid habitat within the action area include: freshwater rearing habitat, freshwater migration corridors, and estuarine areas. The essential features of these PCEs include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food; riparian vegetation, space, and safe passage conditions. The intended conservation rolls of these habitats are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults. The conservation condition and function of this habitat has been severely impaired through several factors discussed in the *Status of the Species and Habitat* section of the programmatic biological opinion. The result has been the reduction in quantity and quality of several essential features of migration and rearing habitat required by juveniles to grow, and survive. In spite of the degraded condition of this habitat, the intrinsic conservation value of the action area is high because the entire length is used for extended periods of time by a large proportion of all Federally listed anadromous fish species in the Central Valley.

The current condition of proposed critical habitat for North American green sturgeon in the action area is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, particularly in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the Southern DPS of green sturgeon evolved. The habitat values for green sturgeon proposed critical habitat have suffered similar types of degradation as already described for winter-run critical habitat. In addition, the degradation of the Sacramento-San Joaquin River Delta habitats (as previously described for the salmonid species), may have a particularly severe impact on the survival and recruitment of juvenile green sturgeon due to their protracted rearing time in the delta and estuary.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This addendum to the biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat in 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This addendum to the programmatic biological opinion assesses the effects of the proposed action on endangered Sacramento River winter-run Chinook salmon, threatened CV spring-run Chinook salmon, threatened CV steelhead, threatened Southern DPS of North American green sturgeon, and their designated and proposed critical habitat.

In the *Description of the Proposed Action* section of this biological opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this biological opinion, NMFS provided an overview of the threatened and endangered species and critical habitat that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. §1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment. These effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a deleterious sound. Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable exposure to those effects (the extent of temporal and spatial overlap between individuals of the species and the effects of the action). Once we have identified the species likely exposure to an action we evaluate the available evidence to identify a species' probable response (including behavioral responses) to their exposure to the effects of the action to determine if those effects could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

The final step in conducting the “jeopardy” analysis is to consider the additive effects of the environmental baseline, the effects of the action and any reasonably foreseeable cumulative effects to determine the potential for the action to affect the survival and recovery of the species, or the conservation value of their designated or proposed critical habitat.

To evaluate the effects of the proposed action, NMFS examined proposed construction activities, O&M activities, habitat modification, and conservation measures, to identify likely impacts to listed anadromous fish within the action area based on the best available information.

The information used in this assessment includes fishery information previously described in the *Status of the Species* and *Environmental Baseline* sections of this biological opinion; studies and accounts of the impacts of riprapping and in-river construction activities on anadromous habitat and ecosystem function; and documents prepared by the Corps in support of the proposed action (Corps 2007, 2008); SAM results; project designs; field reviews, and meetings held between the Corps, NMFS, USFWS, and CDFG.

The programmatic biological opinion analyzed the short- and long-term effects of actions, but did not provide details on the project-specific effects that are described in the *Project Description*, section of this addendum. This assessment will summarize the effects analysis from the programmatic biological opinion and review the more specific effects of the12 proposed levee repairs.

B. Summary of Effects Analyzed in the Programmatic Biological Opinion

NMFS expects that relatively low number of anadromous salmonids will be present in the action area during construction activities because the construction periods do not occur during peak migration periods. Those fish that are exposed to these activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or death by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. Some juvenile fish may be crushed, and killed or injured during rock placement, especially fry-sized winter-run Chinook salmon that may be present in region 3. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Construction will not occur during peak migration periods; therefore relatively few juvenile fish are expected to be injured or killed by in-river construction activities because most fish are expected to avoid daytime construction activities due to their predominately crepuscular migration behaviors. The implementation of BMPs and other conservation measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. In addition, and with the exception of the occurrence of winter-run Chinook salmon in region 3, peak migration events correspond with periods of high river flows, when in-river construction activities are likely to be suspended. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each salmon and steelhead population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

NMFS expects that a large, but unknown, number of green sturgeon will be present in the action area during construction because peak migration and spawning periods occur during this time. Green sturgeon are primarily benthic, and their presence along the shoreline is not common. Therefore, adverse effects including injury or death from construction activities are not expected.

The project is expected to result in long-term habitat modifications, including modifications to the designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead and proposed critical habitat for Southern green sturgeon. The modifications will affect fish behavior, growth and survival, and the PCEs of critical habitat including freshwater and estuarine rearing sites and migration corridors.

The programmatic biological opinion evaluated long-term impacts as modeled by the Corps Standardized Assessment Methodology (SAM). The SAM was developed by the Corps, in consultation with NMFS, USFWS, CDFG and CDWR, to address specific habitat assessment and regulatory needs for ongoing and future bank protection actions in the SRBPP action area. The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species (with the exception of Southern DPS green sturgeon). A major advantage of the SAM is that it integrates species life history and flow-related variability in habitat quality and availability to generate species responses to project actions over time. Species responses represent an index of a species growth and survival based on a 30-day exposure to post project conditions for a variety of seasons and life-history stages, over the life of the project.

In regions 1a and 1b, and during all seasons, SAM results indicate that short- to long-term habitat deficits would potentially occur under the expected proportions of the project designs. Throughout these two regions, the identified erosion sites (Ayres 2005, 2006) were concentrated along bank segments that contain relatively high proportions of in-stream and overhead cover; the erosion sites in regions 2 and 3 were typically situated along banks containing lower proportions of beneficial bank attributes such as shade, IWM, and shallow slope. As a result, when utilizing the expected proportions of the four bank repair designs, the differences between existing and with-project conditions were greater at the representative erosion sites of regions 1a and 1b; these differences in turn resulted in greater habitat deficits compared to those within regions 2 and 3. Based on the SAM results, at the representative project sites in regions 2 and 3, initial short-term habitat deficits recovered to existing conditions by year 5 at the latest in winter and spring, and by year 15 in summer and fall. Despite the deficits modeled throughout all four regions, habitat responses exhibited continuous and long-term improvement over the modeled time-period, due to the on-site mitigating features that are implemented as part of the four project designs, especially designs 3 and 4, which include the most comprehensive elements.

Within regions 1a and 1b during all seasons, small, but long-term habitat deficits would potentially occur from the repair of levee erosion sites under the expected proportions of the project designs assessed in the programmatic biological opinion. Off-site habitat compensation utilizing one of three potential measures (setback levees, IWM installation, and shallow bank slope construction) would be implemented to off-set the project-wide habitat deficits with long-term habitat gains, for all salmonid life stages. The SAM results indicated that habitat responses benefited most with the off-site compensation measure of installing IWM. With the IWM installation measure, all habitat responses exhibited rapid recovery by year 1, with long-term habitat gains through the modeled time period. Compensation from the shallow bank slope measure offered the fewest habitat benefits to the focus species life stages compared with the benefits provided by the other two measures. If implemented 5 years prior to construction of the project designs, compensation from the setback levee measure resulted in habitat response recovery by year 5 at the latest, followed by substantial habitat gains for the focus species life stages in winter and spring, primarily by seasonal floodplain inundation.

The project, as a whole (*i.e.*, all sites and all regions combined) will cause short-term (*i.e.*, 2 to 12 years) adverse effects to juvenile rearing and migration PCEs, and substantial long-term (*i.e.*, 5 to 50 years) improvements to these PCEs at most seasonal flow elevations. Most deficits result from short-term reductions in vegetation and shade caused by construction and extension of the shoreline away from existing vegetation and shade. Revegetated areas must grow for several years before shade extends over the shoreline. Fall and summer deficits also result from the conversion of shallow-water habitat with fine-textured substrate to large angular rock placed at a 2:1 or 3:1 slope. Despite the modeled summer and fall habitat deficits, they are not expected to reduce the overall conservation condition of rearing and migration PCEs because they will be short-term and the conservation condition will improve to a level above that of the current baseline conditions over the 50 year life of the project.

C. Effects of the 12 Proposed Levee Repair Sites

This section analyzes the site- and regional-scale effects of the 12 proposed levee repairs. Similar to the programmatic analysis, the SAM results indicate mostly short-term (*i.e.*, 1 to 5 years) and some longer-term (*i.e.*, greater than 5 years) deficits, followed by positive increases over the existing baseline condition over the modeled 50-year project period. The initial (*i.e.*, year 0) removal or reduction of several habitat variables during project construction, including the temporary removal of IWM, and aquatic vegetation, drove the short-term deficits. The greatest deficits occur at summer and fall flow elevations at sites having only a riparian bench due to long-term increases in substrate size at these elevations, and because the water level intersects the bank below the elevation of the planted riparian bench.

For the summary of the SAM results, the 12 repair sites have been organized by their associated region within the SRBPP action area. The discussion of effects focuses on the cumulative effects per region, rather than the specific results from each site. However, for reference, the individual site level deficits are shown in Appendix A to this addendum to the programmatic biological opinion, Tables 11 through 92 and Figures 10 through 107. Results per region are shown in Appendix A, Tables 3 through 5 and Figures 1 through 16. These tables and figures are respectively excerpts from the draft EA/IS and as an email response to our request.

1. Region 1a (Sacramento RM 0-20)

There are no repairs sites in region 1a. Repairs sites chosen at this region will be conducted at another year due to complexity of the repair and real estate procedures for right of way.

2. Region 1b (Sacramento RM 20-80)

There are four sites in region 1b including 2 on the Sacramento River and 2 on the lower American River. The repair designs planned for the sites in this region are either a 10:1 slope planted riparian benches (one site: SAC 73.5L)) or an undulating bench (three sites: SAC 35.4L LAR 10.0L and 10.6L), all to be planted with wetland and riparian vegetation. On SAC 73.5L, the IWM replacement would cover 100 percent of the shoreline area along the repair site, while SAC 35.4L would cover 80 percent and LAR 10.0L and 10.6L would cover 40 percent. Generally, the with-project SAM values for all variables are greater than without-project values at winter and spring water surface elevations, while values at the summer and fall elevations are lower for short periods or remain at baseline. The planted riparian bench will provide high value shallow water habitat with increased bankline cover, fine substrate size, shade, and submerged vegetation at winter- and spring flows. In contrast, increased slope, larger substrate, increases in IWM, with decreases in submerged vegetation, shallow water habitat, and shade will cause temporary declines or maintain baseline conditions at the fall and summer water surface elevations.

3. Region 2 (Sacramento RM 80-143, Feather River and Sutter Bypass)

There are eight sites in region 2 including the Feather River (FR 5.5l and 7.0L) and Sutter Bypass (SBP 0.4E). The planned design for the five sites in the Sacramento River (SAC 87.0L, 93.7L, 114.5R, 136.7R, and 136.9R) is a 10:1 slope riparian bench with anchored IWM and willow fascine plantings. The planned design for the Feather River site is similar to the design in the Sacramento but the slope would be a 6:1 ratio. The American River site would have an undulating riparian bench while the Sutter Bypass would have a flat bench with sedges. All of the Sacramento sites and FR 5.5L in this region would have 100 percent bank cover with IWM. FR 7.0L would have 80 percent bank cover and 25 percent bank cover for SBP 0.4E. Despite an initial reduction in shade following construction, the planted wetland bench with IWM will increase shallow water habitat and increase habitat values above baseline at all water surface elevations for the life of the project.

4. Region 3 (Sacramento RM 143-194)

There are no repairs sites in region 3. Repairs sites chosen in this region will be conducted in another year due to complexity of the repair and real estate procedures for right of way.

D. Summary of Effects

1. <u>Construction-related Effects</u>

NMFS expects that a relatively small but unknown number of anadromous salmonids will be present in the action area during construction activities due to migration timing overlapping with construction activities. Only those fish that are holding adjacent to or migrating past a project site are likely to be exposed or affected. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or death by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. Some juvenile fish may be crushed, and killed or injured during rock placement, especially fry-sized winter-run Chinook salmon that may be present in region 3. Others may be displaced from natural shelter and preyed upon by piscivorous fish. Although some construction activities will occur during peak migration periods, relatively few juvenile fish are expected to be injured or killed by in-river construction activities because most fish are expected to avoid construction activities due to their predominately crepuscular migration behaviors. The implementation of BMPs and other conservation measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. Additionally, in region 2, the occurrence of winter-run Chinook salmon peak migration events correspond with periods of high river flows, when in-river construction activities are likely to be suspended. Furthermore, only one cohort, or emigrating year class, out of perhaps four to five within each salmon and steelhead population will be affected. Therefore, NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance, and not likely to result in any long-term, negative population trends. Adults should not be injured because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

Green sturgeon may be present holding and spawning in region 2 and their spawning habitat and spawning behavior may be affected if rock is placed into deepwater habitats in the upper regions of the action area. There are eight projects located in these reaches, and none one of them is being constructed within the known spawning habitat of the species, the number of fish likely to be affected is low and limited to the areas directly adjacent to the construction sites.

2. <u>SAM Modeled Project Effects to the Species and their Designated or Proposed Critical Habitat</u>

Project-scale SAM responses and region-scale SAM responses, as detailed in Appendix A of this document, Tables 3 through 5 and Figures 1 through 16, respectively, are consistent with the parameter of effects analyzed in the programmatic biological opinion. In general, NMFS expects that the most significant project-level habitat deficits will occur at summer and fall flows due to the inherent difficulty of successfully establishing riparian vegetation in a zone that is impacted by boat wake erosion, and variable flow conditions typical of a regulated river system. The modeled summer and fall habitat deficits are expected to affect relatively few fish, since the majority of adult migration and juvenile rearing and emigration within the action area does not occur during average fall flow conditions. Instead, a significant majority of Chinook salmon and steelhead adult migration and juvenile rearing and emigration occurs during periods of higher flow that are more accurately represented by conditions at average winter and spring water surface elevation (WSEL). Short-term habitat deficits at winter and spring WSELs are expected to cause injury and death of individuals at all sites from reduced growth conditions and increased predation, for 2 to 12 years. Long-term effects at the winter and spring WSELs will be substantially positive, with conditions improving beyond existing conditions through year 50.

Additionally, the Corps has agreed to double the amount of IWM percent shoreline cover for certain repair sites to compensate for the negative habitat values revealed in the SAM modeling. SAC 35.4L and FR 7.0L would be increased from 40 percent shoreline coverage to 80 percent, while SAC 73.5L, SAC 87.0L, SAC 93.7L, SAC 114.5R, Sac 136.7R, SAC 136.9R, and FR 5.5L would increase from 50 percent shoreline coverage to 100 percent. Since the repair sites LAR 10.0L and 10.6L would impact 0.6 acres of spawning habitat, DWR plans to contribute towards US Bureau of Reclamation's Spawning Gravel Augmentation project at a 2:1 ratio (total = 1.19 acres) to compensate adequately for the spatial and temporal impacts to potential spawning habitat and conduct a 3-year monitoring study of the spawning gravel to evaluate whether additional credits need to be purchased.

Modeled summer and fall habitat deficits represent impacts to the critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CV steelhead. Affected PCEs include adult and juvenile freshwater and estuarine rearing and migration habitat. Despite short-term deficits, the impact of the projects are not expected to reduce the overall conservation condition of rearing and migration PCEs because the adverse effects will be reduced through the integration of numerous fish habitat features that will limit any alteration of habitat to only a short time, with overall habitat values increasing above baseline conditions over the 50 year life of the project.

NMFS also expects the action to adversely affect the Federally listed Southern DPS of the North American green sturgeon. Adverse effects to these species are expected to be limited to migrating and rearing larvae, post-larvae, juveniles and holding adults. Juveniles are expected to be affected most significantly because of their small size, reliance on aquatic food supply (allochthonous food production), and vulnerability to factors that affect their feeding success and survival. Construction activities will cause disruptions from increased noise, turbidity, and inwater disturbance that may injure or kill larvae, post-larvae, and juvenile green sturgeon by causing reduced growth and survival as well as increased susceptibility to predation. Adverse affects to adults are primarily limited to the alteration of habitat below the waterline affecting predator prey relationships and feeding success. In the absence of modeled response data for green sturgeon, NMFS expects responses to long-term, project-related habitat conditions to be similar to those experiences by salmonids, as described above in *Long-term Effects of SRBPP Actions on Anadromous Salmonids*. However, because green sturgeon are not as near-shore oriented as juvenile Chinook salmon, the relative proportion of the green sturgeon population that will be affected by these conditions should be low.

Food resources, substrate type, size, water quality, depth, and sediment quality are the freshwater riverine PCEs for Southern green sturgeon that are expected to be impacted by the proposed project. NMFS expects that several of the PCEs would be affected over the long term. The habitat for benthic invertebrates would be disrupted from the construction activities, limiting the availability of food supply. The building of 10:1 slope benches would fill-in existing holes and the use of large riprap would change the substrate type and reduce water depths, thus decreasing available habitat for rearing and spawning. However, impacts to water quality would be temporary during the construction period and NMFS expects no long-term effects to water quality.

3. Effects of Project Monitoring

The individual monitoring plans for the project sites include physical habitat and fishery monitoring. The physical habitat monitoring will evaluate how sites meet the compensation criteria of the SAM modeling. The monitoring of physical habitat attributes will use passive measurement techniques that are not expected to adversely affect listed fish or critical habitat.

The fishery monitoring program is generally described in the programmatic biological opinion. Implementation of the proposed monitoring program is expected to result in capture, injury and mortality of juvenile salmonids. Up to 10,000 linear feet of the action area may be monitored several times per year and under variable flow conditions. Under the assumptions made in the programmatic biological opinion, NMFS expects a total of 12,000 juvenile salmonids would be captured per year. Assuming that 95 percent of the captured fish are non-listed CV fall-run Chinook salmon, based on juvenile abundance estimates at Red Bluff Diversion Dam (Gaines and Martin 2002) only 600 of the captured fish would be listed salmonids. Assuming an injury rate of 10 percent (a conservative estimate that doubles the level observed by McMichael *et al.* (1998)), 60 listed salmonids may be injured. At a mortality rate of 5 percent (common level reported in the Central Valley), an additional 30 juvenile fish would be killed. If the capture, injury, and mortalities are divided equally between Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead (an assumption based on an equal level of effort occurring during the migration period of each species without accounting for fluctuating juvenile population abundance), the monitoring would result in the annual capture of approximately 200 fish, the annual injury of 20 fish, and the annual mortality of 10 fish for each ESU/DPS. These amounts are divided equally. Actual levels should be lower because not all sites will be sampled, and river flows and scheduling complexities are likely to reduce the sampling frequency to fewer than six times per year. Because sampling will be limited to nearshore areas, and will not occur in adult migration corridors, no more that 1 adult of each species is expected to be captured each year with a 95 percent survival rate of captured adults.

Green sturgeon are not expected to be encountered, injured or killed during electrofishing activities. This expectation is based on the fish's preference for deep habitats within the river corridor, and the understanding that electrofishing will be conducted in shallow water habitats along river margins. Additionally, the electrofishing of levee repair sites throughout the action area over the past two years has not yielded any green sturgeon.

The number of fish that will be captured, injured, or killed is expected to be relatively low compared to the overall abundance of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. The anticipated low levels of capture, injury, and mortality are not expected to result in population level impacts. Monitoring results will be used to validate the effectiveness of project conservation measures for avoiding or minimizing adverse impacts of bank protection projects on Federally listed fish species, and are expected to result in improved methods and strategies to reduce impacts of future bank protection projects on listed salmonids.

The green sturgeon monitoring plan is expected to capture and tag 40 green sturgeon per year, during August and September, for 3 years totaling 120 individuals. ERDC and UC Davis scientists expect 19 adults and 21 sub adults to be captured each year. Detailed capture and handling protocols insure that the individual tagged sturgeon would be handled carefully to the maximum extent possible and would be released in good condition. Because information on the overall population size of green sturgeon in the Sacramento River Basin is limited, NMFS can not accurately determine the extent of impacts that these types of capture and monitoring activities would have on the green sturgeon population. However, due to the high survival rate and low apparent impacts on green sturgeon captured and monitored in similar studies in the Sacramento River (Heublein *et al*. 2008, Kelley *et al.* 2006), NMFS expects that impacts to the Southern DPS of North American green sturgeon resulting from the proposed monitoring activities will be minimal, and will not result in population level impacts to the DPS. NMFS also finds that the data obtained from the tagging and monitoring of these fish would add to the needed data for green sturgeon so better management decisions could be implemented.

4. <u>Effects of Project Operations and Maintenance</u>

O&M activities are expected to occur between July 1 and August 31for the life of the project (*i.e.*, 50 years) to maintain the flood control and environmental values of the site. Anticipated O&M actions include vegetation management and irrigation for up to three years, periodic rock placement to prevent or repair localized scouring, and periodic replacement or modification of IWM structures. Effects would be limited to the annual placement of up to 600 cubic yards of material at each site. Impacts from O&M actions generally will be similar to the impacts of initial construction, except that they will be smaller and more localized. Effects may include injury or death to salmon and steelhead from predation caused by turbidity changes that temporarily disrupt normal behaviors, and affect sheltering abilities. However, since O&M actions are only expected to repair damaged elements of the project, they are expected to be infrequent (*i.e.*, occurring only once every several years), small (*i.e.*, only affecting small sections of the project area), and will not occur at all sites. Therefore relatively few fish should be affected by O&M actions, and actual injury and mortality levels will be low relative to overall population abundance and not likely to cause any long-term, negative population responses. Any O&M actions that affect habitat conditions will incorporate BMPs, summer in-water construction windows, and other minimization and avoidance measures to reduce the potential for effects to anadromous salmonids, green sturgeon, and their designated and proposed critical habitat.

5. <u>Interrelated or Interdependent Actions</u>

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Within the programmatic biological opinion, NMFS considered concurrent, ongoing repair of additional PL 84-99 repairs currently being proposed by the Corps as potentially interrelated or interdependent actions to the proposed action. These projects are expected to result in effects to listed salmon, steelhead, and sturgeon that are similar to those previously described in this addendum to the programmatic biological opinion, including short-term adverse effects to these species and their designated and proposed critical habitat. NMFS does not consider these actions to be interrelated because there is no single authority or program that binds them together, nor are they interdependent because they would occur regardless of the proposed action.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this addendum to the programmatic biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Cumulative effects that are reasonable certain to occur in the action area are summarize in detail in the programmatic biological opinion and include non-Federal riprap projects, continuing or future non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic habitat to simplified habitats, entrainment, and reduced growth and survival.

VII. INTEGRATION AND SYNTHESIS

This section considers the *Effects of the Action*, and the *Integration and Synthesis* section of the programmatic biological opinion, which includes analysis of the *Environmental Baseline, Cumulative Effects*, and the effects of the programmatic action.

A. Impacts of the Proposed Action on the Survival and Recovery of Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, Central Valley Steelhead and the Southern DPS of North American green sturgeon

The *Environmental Baseline* section of the programmatic biological opinion and this addendum describe how recent evaluations of the viability of Central Valley salmonids found that extant populations of Sacramento River winter-run Chinook salmon and CV steelhead appear to be fairly viable because they meet several viability criteria including population size, growth, and risk from hatchery strays. The viability of the ESU to which these populations belong appears low to moderate, as the ESU remains vulnerable to extirpation due to their small-scale distribution of independent populations and high likelihood of being affected by a significant catastrophic event. Lindley *et al*. (2007) were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extirpation since most of the historic habitat is inaccessible due to dams, and because the anadromous life-history strategy is being replaced by residency. The continued existence of green sturgeon in the Sacramento River and the observation of sturgeon in the Feather and Yuba Rivers indicate that the population is viable and faces a low to moderate risk of extinction. The largest threats to the viability of the ESUs and DPS' are related to loss of access to historic habitats, and the existence of few independent populations, which places the species at risk of extirpation from catastrophic events.

The *Cumulative Effects* section of the programmatic biological opinion and this addendum described how future State, tribal, local, or private actions that are reasonably certain to occur in the action area include non-Federal riprap projects, continuing or future non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

The proposed action, as described in the programmatic biological opinion and in detail in this addendum, has specifically been designed to minimize and avoid continued nearshore aquatic and riparian habitat loss from large-scale bank protection projects. The proposed implementation of the integrated conservation measures and the commitment to implement additional compensation measures and conduct a final post-project SAM assessment will ensure that short- and long-term impacts associated with these bank protection projects will be compensated in a way that prevents incremental habitat fragmentation, and loss throughout the action area. Although some injury or death to individual fish is expected from construction activities, O&M, and short- and long-term habitat modification, successful implementation of all conservation measures is expected to improve migration and rearing conditions, and the growth and survival of juvenile salmon and steelhead during peak rearing and migration periods by protecting, restoring, and in many cases, increasing the amount of flooded shallow water habitat and SRA habitat throughout the action area. Because of this, the proposed action is not expected to reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, or CV steelhead.

The adverse effects to Southern DPS of North American green sturgeon within the action area are not expected to affect the overall survival and recovery of the DPS. This is largely due to the fact that the project will compensate for temporary and permanent habitat losses through implementation of on-site and off-site conservation measures. Construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or larvae, post-larvae, and juvenile fish from rearing or migrating to downstream rearing areas. The number of individuals actually injured or killed is expected to be undetectable and negligible and, population-level impacts are not anticipated. Implementation of the conservation measures will ensure that long-term impacts associated with bank protection projects will be compensated in a way that prevents incremental habitat fragmentation, and reductions of the conservation value of aquatic habitat to anadromous fish within the action area. Because of this, the proposed action is not expected to reduce the likelihood of survival and recovery of the Southern DPS of North American green sturgeon.

B. Impacts of the Proposed Action on Critical Habitat

1. Salmon and Steelhead

Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead include the short- and long-term modification to the migratory corridor and spawning habitat at 12 levee repair sites. PCEs include estuarine and riverine areas for juvenile rearing and migration and adult migration. NMFS' CHART (2005) described existing PCEs within the action area as ranging from high quality to degraded, with isolated fragments of high quality habitat. Even with these degraded condition, the CHART report found that the intrinsic value of the entire action area is high because it is used as a rearing and migration corridor for all populations of winter-run Chinook salmon and CV spring-run Chinook salmon, and by the largest populations of CV steelhead.

Impacts to PCEs generally will last for 2 to 12 years and result from loss or modification of riparian vegetation, shallow-water habitat, and the increase in bank substrate size. These losses and modifications affect juvenile rearing and migration PCEs by reducing in-stream cover and food production. The intended conservation roll of the critical habitat in the action area is primarily as a migration corridor. Freshwater migration corridors must function sufficiently to provide adequate passage; project effects are not expected to reduce passage conditions based on the length of time individual juvenile salmonids will be exposed to the reduced quality and availability of refuge areas as they transit through the action area. Thus, NMFS does not expect the 2 to 12 year reduction in the quality and availability of refuge areas in this reach of the river to impact the current function of the action area or affect its ability to reestablish essential features that have been impacted by past and current actions. From year 12 through 50, the PCEs will improve as vegetation matures and extends over the shoreline. The improved habitat conditions are expected to improve the growth and survival of juvenile fish. Therefore, we do not expect project-related impacts to reduce the conservation value of designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead.

2. Proposed Critical Habitat for North American Green Sturgeon

Impacts to the proposed critical habitat of Southern DPS of North American green sturgeon include the short- and long-term modification to the freshwater riverine system at 12 levee repair sites. PCEs include food resources, substrate type and size, water quality, migratory corridor depth and sediment quality for juvenile rearing and migration and adult spawning and migration. The building of 10:1 slope benches would fill-in existing deep water habitat and the use of large riprap would change the substrate type and reduce water depths, thus decreasing available habitat for rearing and potential spawning habitat. The rearing habitat for benthic invertebrates would be disrupted from the construction activities, limiting the availability of food supply. However, typical recolonization of new substrate occurs when these drifting invertebrate larvae and plants encounter open substrate as they are dispersed into the barren fill area by river flows sweeping through the channel. Although initially the community composition of the newly colonized substrate is likely to be different than the surrounding channel, a mature benthic community resembling the surrounding area is expected to form with the passage of time if the substrate does not encounter any further disturbances. In addition, since the deepest areas along the repairs sites are less than nine feet in depth, it is unlikely the green sturgeon would be utilizing these holes for spawning. (Hampton, 2009. pers comm., NMFS). The substrate along the repair sires generally consists of mixed fine clayish silt and angular rocks. Disturbance of these substrates is likely to create a suspended sediment plume along the shoreline for a short distance downstream of the repair sites; however, impacts to water quality would be temporary during the construction period and NMFS expects no long-term effects to water quality.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, the Southern DPS of North American green sturgeon, and CV steelhead, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the construction of the proposed 12 levee repair sites and associated operations, maintenance, and monitoring, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, the Southern DPS of North American green sturgeon, or CV steelhead, and is not likely to destroy or adversely modify their designated or proposed (green sturgeon) critical habitat.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The listing of the Southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). On May 21, 2009, the proposed rule for section 9(a), Take Prohibitions, for threatened Southern DPS of North American green sturgeon was established, the incidental take statement, as it pertains to the Southern DPS of North American green sturgeon becomes effective with the issuance of a final 4(d) regulation.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any contract or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (1) fails to assume and implement the terms and conditions, or (2) fails to require the contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NMFS as specified in this incidental take statement (50 CFR §402.14(i)(3)).

A. Amount and Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, CV steelhead, CV spring-run Chinook salmon, and the Southern DPS of North American green sturgeon from impacts related to construction, O&M, and through long-term impairment of essential behavior patterns as a result of reductions in the quality or quantity of their habitat. Take is expected to be limited to migrating adults, and migrating, rearing and smolting juveniles.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to describe the general programmatic conditions and ecological surrogates that will lead to the take at both the regional and project-wide scale.

Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon incidental to the action resulting from short-term construction impacts, as well as long-term impacts as indexed by the SAM model, as presented in Appendix A of this addendum to the programmatic biological opinion. The following level of incidental take from program activities is anticipated:

1. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon in the form of injury and death from predation caused by construction-related turbidity that extends up to 100 feet from the shoreline, and 1,000 feet downstream, along all project reaches for construction that occurs from August 1, 2008 to November 30, 2008.

2. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon, in the form of harm or injury of fish from O&M actions is expected from habitat-related disturbances from the annual placement of up to 600 cubic yards of material per site for the extent of the project life (*i.e.*, 50 years). Take will be in the form of harm to the species through modification or degradation of juvenile rearing and migration habitat.

3. Take in the form of harm, injury, and death of rearing and smolting Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the Southern DPS of North American green sturgeon at fall, summer, spring, and winter WSELs from the modification of nearshore habitat that adversely affects the quality and quantity of juvenile Chinook salmon, steelhead, and green sturgeon habitat as represented by the SAM results shown in Appendix A.

4. Take in the form of capture from monitoring activities is not expected to exceed an annual amount of 200 juvenile fish for each Federally listed anadromous salmonid ESU or DPS. Take in the form of injury is not expected to exceed an annual amount of 20 juvenile fish for each Federally listed anadromous salmonid ESU or DPS. Take in the form of death from monitoring activities is not expected to exceed an annual amount of 10 juvenile fish for each Federally listed anadromous salmonid ESU or DPS. Take in the form of capture, injury, or death is not expected to exceed one adult fish per year for each Federally listed anadromous salmonid ESU or DPS.

5. Take in the form of capture from monitoring activities is not expected to exceed an annual amount of 40 green sturgeon (19 adults and 21 subadults) for Federally listed Southern DPS of North American green sturgeon. Take in the form of injury (due to surgical implantation of telemetry tags) is not expected to exceed an annual amount of 40 adult and subadult Federally listed Southern DPS of North American green sturgeon. Take in the form of death from capture and monitoring activities is not expected to exceed an annual amount of 1 adult or subadult for Federally listed Southern DPS of North American green sturgeon.

Anticipated incidental take may be exceeded if project activities exceed the criteria described above, if the project is not implemented as described in the biological assessment prepared for this project, or if the project is not implemented in compliance with the terms and conditions of this incidental take statement.

B. Effect of the Take

NMFS has determined that the above level of take is not likely to jeopardize Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, or the Southern DPS of North American green sturgeon. The effect of this action in the proposed project areas will consist of fish behavior modification, temporary loss of habitat value, and potential death or injury of juvenile Sacramento River winter-run Chinook salmon, CV steelhead, and CV spring-run Chinook salmon, and the Southern DPS of North American green sturgeon.

C. Reasonable and Prudent Measures

NMFS has determined that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of listed anadromous fish.

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for juvenile salmonids, and the Southern DPS of North American green sturgeon.

3. Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this biological opinion.

4. Measures shall be taken to insure that the scientist conducting the Southern DPS of North American green sturgeon study implement conservation measures in handling and releasing green sturgeon and provide adequate data and reports.

D. Terms and Conditions

1. Measure shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

    a. The Corps shall continue to coordinate with the IWG agencies and the Technical Team of the Interagency Collaborative Flood Management Program during the implementation and monitoring of these and future repairs.

    b. The Corps shall update their O&M Manual to ensure that the self-mitigating efforts and repair designs meet the expectation of the SAM values.

    c. The Corps shall provide additional annual reports, as necessary, to describe the implementation of off-site conservation measures, to summarize O&M actions, and summarize monitoring results.

    d. The Corps shall establish and chair a Project Monitoring Subcommittee to plan monitoring efforts and provide technical support to the Corps for tracking compliance with the biological opinion.

    e. The Corps shall increase the duration of project-specific monitoring from 5 to 10 years for all SAM-modeled measures. NMFS does not expect that all measures or all sites will require 10 years of monitoring. Instead, through ongoing cooperation with the IWG agencies, and the Project Monitoring Subcommittee, a select, representative group of project sites will be monitored for this period. This requirement is based on the need to help validate that projects with SAM-modeled results are on a positive trajectory and successfully reaching or exceeding baseline values.

Monitoring the effectiveness of the measures installed to meet SAM values may require scientific inquiry that extends beyond in-stream data collection. Tools such as computer modeling and hydraulic models as well as tagging studies should be used as necessary to assess the relative value of each element of the SAM model. In-stream studies must include sampling procedures to determine species composition and abundance together with physical observations and measurements at selected construction and control sites.

f. Electrofishing shall be conducted following NMFS Electrofishing Guidelines.

g. The Corps shall develop a database for storing site monitoring data. The database shall include fields that track SAM-modeled habitat attributes and fishery data over time. The database shall be developed with the oversight the Project Monitoring Subcommittee.

h. The Corps shall ensure that, for the life of the project, future maintenance actions ensure performance of the sites to a level necessary to retain the SAM-modeled habitat values.

2. Measures shall be taken to minimize the impacts of bank protection by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for juvenile salmonids.

a. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place. NMFS shall be contacted prior to the removal of any tree greater the 4 inches dbh.

b. The landscape plan for all sites shall include planting fascine bundles as close as possible to the mean August WSEL to provide in-stream vegetation and shoreline shading from 1 year to 5 years following repairs.

c. The Corps shall ensure that the planting of native vegetation will occur within the same year that construction occurs. All plantings must be provided with the appropriate amount of water to ensure successful establishment.

d. The Corps shall prepare an updated SAM assessment of all sites upon completion of Phase II. If this assessment shows additional uncompensated habitat deficits, the Corps must provide a compensation strategy to NMFS within 3 months, and any necessary additional compensation must be completed within 12 months.

e. The Corps shall limit the inwater construction period for routine O&M actions to July 1 to August 31.

f. The Corps shall limit inwater construction in region 3 to between July 1 and August 31.

g. The Corps shall develop and implement an advanced compensation strategy and to the extent practicable, implement compensatory actions prior to the construction of bank protection projects.

3. Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this biological opinion.

a. The Corps shall provide a copy of the programmatic biological opinion and this addendum to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirements of the programmatic biological opinion and this addendum. A notification that contractors have been supplied with this information will be provided to the reporting address below.

b. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this addendum to the programmatic biological opinion. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training. As needed, training shall be conducted in Spanish for Spanish language speakers and other languages as needed or necessary.

4. Measures shall be taken to insure that the scientist conducting the Southern DPS of North American green sturgeon study implement conservation measures in handling and releasing green sturgeon and provide adequate data and reports.

a. The Corps scientist shall capture and handle not more than 40 Southern DPS of North American green sturgeon per year during their three year study. Modifications to the study shall require that the Corps contact NMFS for approval.

b. The Corps scientist shall not hold an individual Southern DPS of North American green sturgeon more than 60 minutes.

c. The Corps scientist shall document and report types of injury and death of a Southern DPS of North American green sturgeon to NMFS.

d. The Corps scientist shall organize and store raw and analyzed data in a data system that is accessible for resource agencies to obtain and view.

e. The Corps scientist shall provide monitoring updates during the IWG monthly meeting and a yearly report of their data on December 30, 2009.

Reports and notifications required by these terms and conditions shall be submitted to:

Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento California 95814-4706
FAX: (916) 930-3629
Phone: (916) 930-3600

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These conservation recommendations include discretionary measures that the Corps can implement to further the conservation of listed species and critical habitat, and further the development of information on the conservation of these species.

1. The Corps, under the authority of section 7(a)(1) of the ESA, should implement recovery and recovery plan-based actions within and outside of traditional flood damage reduction projects. Such actions may include, but are not necessarily limited to restoring natural river function and floodplain development.

2. The Corps should cooperate with local levee maintenance districts, flood control agencies, and State and Federal resource agencies to develop an anticipatory erosion repair program that emphasizes the use of biotechnical techniques, and minimizes the use of rock rip rap to treat small erosion sites before they become critical.

3. The Corps should make set-back levees integral components of the Corp’s authorized bank protection or ecosystem restoration efforts.

4. The Corps should evaluate the SRFCP’s effectiveness for providing flood damage reduction using regional climate change forecasts and anticipated shifts in precipitation and other related hydrologic regimes.

5. The Corps should make more effective use of ecosystem restoration programs, such as those found in Sections 1135 and 206 of the respective Water Resource Developments Acts of 1986 and 1996. The section 1135 program seems especially applicable as the depressed baselines of the Sacramento River winter-run Chinook salmon, CV steelhead, and CV spring-run Chinook salmon are, to an appreciable extent, the result of the Corps’ SRBPP program.

6. The Corps should incorporate the costs of conducting lengthy planning efforts, involved consultations, implementation of proven off-site conservation measures, and maintenance and monitoring requirements associated with riprapping into each project’s cost-benefit analysis such that the economic benefits of set-back levees are more accurately expressed to the public and regulatory agencies. This includes a recognition of the economic value of salmonids as a commercial and sport fishing resource.

7. The Corps should conduct or fund studies to identify set-back levee opportunities, at locations where the existing levees are in need of repair or not, where set-back levees could be built now, under the SRBPP, or other appropriate Corps authority. Removal of the existing riprap from the abandoned levee should be investigated in restored sites and anywhere removal does not compromise flood safety.

8. As recommended in the NMFS Proposed Recovery Plan for the Sacramento River winter-run Chinook Salmon (NMFS 1997), the Corps should preserve and restore riparian habitat and meander belts along the Delta with the following actions: (1) avoid any loss or additional fragmentation of riparian habitat in acreage, lineal coverage, or habitat value, and provide in-kind compensation when such losses are unavoidable (*i.e.*, create meander belts along the Sacramento River by levee set-backs), (2) assess riparian habitat along the Sacramento River from Keswick Dam to Chipps island and along Delta waterways within the rearing and migratory corridor of juvenile winter-run Chinook salmon, (3) develop and implement a Sacramento River and Delta Riparian Habitat Restoration and Management Plan (*i.e.*, restore marshlands within the Delta and Suisun Bay), and (4) amend the Sacramento River Flood Control and SRBPP to recognize and ensure the protection of riparian habitat values for fish and wildlife (*i.e.*, develop and implement alternative levee maintenance practices).

9. Section 404 authorities should be used more effectively to prevent the unauthorized application of riprap by private entities.

To be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed or special status species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed implementation of 13 levee repair actions under the authority of the SRBPP. Reinitiation of formal consultation is required if: (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (2) the action, including the avoidance, minimization, and compensation measures listed in the *Description of the Proposed Action* section is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (3) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. LITERATURE CITED

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Enclosure 1

SAM Tables and Figures for the 12 sites

Table 11
SAM data summary of existing conditions at site Sacramento River RM 35.4L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	4.7	6.4	5.9	5.1
Wetted Area (square feet) [2]	264,380	269,558	268,123	265,609
Shoreline Length (feet) [2]	1,076	1,082	1,081	1,078
Bank Slope (dH:dV) [2]	2.7	2.2	2.3	2.6
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.06	1.07	1
Bank Substrate Size (D50 in inches) [3]	16	16	16	16
Instream Structure (% shoreline) [4]	0	0	0	0
Vegetation (% shoreline) [3]	13	38	38	13
Shade (% shoreline) [5]	0	0	0	0

[1] Water surface elevations provided by DWR utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 12
SAM data summary of with-project conditions at site Sacramento River RM 35.4L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	4.7	6.4	5.9	5.1
Wetted Area (square feet)	264,380	269,558	268,123	265,609
Shoreline Length (feet)	1,076	1,082	1,081	1,078
Bank Slope (dH:dV)				
WY 2009 (Year 0)	2.7	2.2	2.3	3.0
WY 2010-2059	3.0	10	10	3.0
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.06	1.07	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	16	16	16	8
WY 2010-2059	8	0.25	0.25	8
Instream Structure (% shoreline)				
WY 2009 (Year 0)	0	0	0	40
WY 2010-2059	40	40	40	40
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	38	38	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	0	0	0	0
WY 2010 (Year 1)	0	1	2	0
WY 2014 (Year 5)	0	9	26	0
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.
With-project conditions based on design and construction specifications provided by DWR.

Table 15

SAM data summary of existing conditions at site Lower American River RM 10.0L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	21.4	21.7	22.8	22.4
Wetted Area (square feet) [2]	115,062	115,936	118,098	117,437
Shoreline Length (feet) [2]	755	755	758	757
Bank Slope (dH:dV) [2]	3.1	2.7	2.1	2.2
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.21	1.19	1
Bank Substrate Size (D50 in inches) [3]	1	1	1	1
Instream Structure (% shoreline) [4]	9	9	9	9
Vegetation (% shoreline) [3]	0	32	32	0
Shade (% shoreline) [5]	64	17	58	76

[1] Water surface elevations provided by DWR utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 16
SAM data summary of with-project conditions at site Lower American River RM 10.0L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	21.4	21.7	22.8	22.4
Wetted Area (square feet)	115,062	115,936	118,098	117,437
Shoreline Length (feet)	755	755	758	757
Bank Slope (dH:dV)				
WY 2009 (Year 0)	3.1	2.7	2.1	3.0
WY 2010-2059	3.0	10	10	3.0
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.21	1.19	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	1	1	1	8
WY 2010-2059	8	0.25	0.25	8
Instream Structure (% shoreline)				
WY 2009 (Year 0)	9	9	9	40
WY 2010-2059	40	40	40	40
Vegetation (% shoreline)				
WY 2009 (Year 0)	0	32	32	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	64	17	58	19
WY 2010 (Year 1)	16	6	19	19
WY 2014 (Year 5)	16	21	64	19
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.

With-project conditions based on design and construction specifications provided by DWR.

Table 17
SAM data summary of existing conditions at site Lower American River RM 10.6L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	21.8	22.1	23.2	22.8
Wetted Area (square feet) [2]	55,608	57,241	61,073	59,900
Shoreline Length (feet) [2]	701	697	687	690
Bank Slope (dH:dV) [2]	3.0	2.6	1.9	2.1
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.47	1.38	1
Bank Substrate Size (D50 in inches) [3]	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [4]	28	28	28	28
Vegetation (% shoreline) [3]	13	88	88	13
Shade (% shoreline) [5]	60	17	66	81

[1] Water surface elevations provided by DWR utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 18
SAM data summary of with-project conditions at site Lower American River RM 10.6L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	21.8	22.1	23.2	22.8
Wetted Area (square feet)	55,608	57,241	61,073	59,900
Shoreline Length (feet)	701	697	687	690
Bank Slope (dH:dV)				
WY 2009 (Year 0)	3.0	2.6	1.9	3.0
WY 2010-2059	3.0	10	10	3.0
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.47	1.38	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	0.25	0.25	0.25	8
WY 2010-2059	8	0.25	0.25	8
Instream Structure (% shoreline)				
WY 2009 (Year 0)	28	28	28	40
WY 2010-2059	40	40	40	40
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	88	88	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	60	17	66	20
WY 2010 (Year 1)	15	5	19	20
WY 2014 (Year 5)	15	16	52	20
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.
With-project conditions based on design and construction specifications provided by DWR.

Table 21
SAM data summary of existing conditions at site Sacramento River RM 73.5L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	11.2	15.8	14.2	12.4
Wetted Area (square feet) [2]	150,210	162,246	158,420	152,685
Shoreline Length (feet) [2]	1,063	1,064	1,064	1,066
Bank Slope (dH:dV) [2]	2.2	1.3	2.0	2.3
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.14	1.16	1
Bank Substrate Size (D50 in inches) [3]	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [4]	32	32	32	32
Vegetation (% shoreline) [3]	13	63	63	13
Shade (% shoreline) [5]	44	15	40	46

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 22
SAM data summary of with-project conditions at site Sacramento River RM 73.5L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	11.2	15.8	14.2	12.4
Wetted Area (square feet)	150,210	162,246	158,420	152,685
Shoreline Length (feet)	1,063	1,064	1,064	1,066
Bank Slope (dH:dV)				
WY 2009 (Year 0)	2.2	1.3	2.0	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.1	1.2	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	0.25	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	32	32	32	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	63	63	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	44	15	40	12
WY 2010 (Year 1)	11	5	13	12
WY 2014 (Year 5)	11	18	53	12
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2010 and revegetation planting assumed during Fall WY 2011.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 29
SAM data summary of existing conditions at site Feather River RM 5.5L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	19.4	20.6	21.0	20.8
Wetted Area (square feet) [2]	159,928	161,015	161,355	161,187
Shoreline Length (feet) [2]	842	842	841	841
Bank Slope (dH:dV) [2]	1.4	1.1	1.1	1.1
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.14	1.14	1
Bank Substrate Size (D50 in inches) [3]	1.9	1.9	1.9	1.9
Instream Structure (% shoreline) [4]	28	28	28	28
Vegetation (% shoreline) [3]	13	63	63	13
Shade (% shoreline) [5]	16	13	38	16

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 30
SAM data summary of with-project conditions at site Feather River RM 5.5L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	19.4	20.6	21.0	20.8
Wetted Area (square feet)	159,928	161,015	161,355	161,187
Shoreline Length (feet)	842	842	841	841
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.4	1.1	1.1	6
WY 2010-2059	6	6	6	6
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.14	1.14	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	1.9	1.9	1.9	2
WY 2010-2059	2	0.25	0.25	2
Instream Structure (% shoreline)				
WY 2009 (Year 0)	28	28	28	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	63	63	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	16	13	38	4
WY 2010 (Year 1)	4	4	13	4
WY 2014 (Year 5)	4	16	49	4
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 31

SAM data summary of existing conditions at site Feather River RM 7.0L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	20.1	22.1	22.5	21.5
Wetted Area (square feet) [2]	125,006	126,451	126,726	126,027
Shoreline Length (feet) [2]	593	592	592	594
Bank Slope (dH:dV) [2]	1.3	1.2	1.1	1.2
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.25	1.24	1
Bank Substrate Size (D50 in inches) [3]	1.7	1.7	1.7	1.7
Instream Structure (% shoreline) [4]	0	0	0	0
Vegetation (% shoreline) [3]	13	38	38	13
Shade (% shoreline) [5]	15	5	16	19

[1] Water surface elevations provided by DWR utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 32
SAM data summary of with-project conditions at site Feather River RM 7.0L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	20.1	22.1	22.5	21.5
Wetted Area (square feet)	125,006	126,451	126,726	126,027
Shoreline Length (feet)	593	592	592	594
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.3	1.2	1.1	2.0
WY 2010-2059	2.0	10	10	2.0
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.25	1.24	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	1.7	1.7	1.7	12
WY 2010-2059	12	0.25	0.25	12
Instream Structure (% shoreline)				
WY 2009 (Year 0)	0	0	0	40
WY 2010-2059	40	40	40	40
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	38	38	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	15	5	16	5
WY 2010 (Year 1)	4	3	10	5
WY 2014 (Year 5)	4	24	72	5
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.
With-project conditions based on design and construction specifications provided by DWR.

Table 33
SAM data summary of existing conditions at site Sacramento River RM 87.0L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	15.8	21.1	19.3	17.1
Wetted Area (square feet) [2]	196,046	204,938	201,284	197,386
Shoreline Length (feet) [2]	758	757	759	762
Bank Slope (dH:dV) [2]	1.8	1.8	2.3	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.16	1.18	1
Bank Substrate Size (D50 in inches) [3]	6	0.25	0.25	6
Instream Structure (% shoreline) [4]	2	2	2	2
Vegetation (% shoreline) [3]	38	63	63	38
Shade (% shoreline) [5]	2	1	3	3

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 34
SAM data summary of with-project conditions at site Sacramento River RM 87.0L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	15.8	21.1	19.3	17.1
Wetted Area (square feet)	196,046	204,938	201,284	197,386
Shoreline Length (feet)	758	757	759	762
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.8	1.8	2.3	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.16	1.18	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	6	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	2	2	2	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	38	63	63	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	2	1	3	1
WY 2010 (Year 1)	1	1	4	1
WY 2014 (Year 5)	1	15	45	1
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 35
SAM data summary of existing conditions at site Sacramento River RM 93.7L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	18.5	24.6	22.8	20.1
Wetted Area (square feet) [2]	149,501	156,182	154,282	151,271
Shoreline Length (feet) [2]	909	914	912	910
Bank Slope (dH:dV) [2]	1.4	1.2	1.1	1.2
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.12	1.13	1
Bank Substrate Size (D50 in inches) [3]	1.7	0.25	0.25	1.7
Instream Structure (% shoreline) [4]	0	0	0	0
Vegetation (% shoreline) [3]	13	38	38	13
Shade (% shoreline) [5]	0	0	0	0

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 36
SAM data summary of with-project conditions at site Sacramento River RM 93.7L.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	18.5	24.6	22.8	20.1
Wetted Area (square feet)	149,501	156,182	154,282	151,271
Shoreline Length (feet)	909	914	912	910
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.4	1.2	1.1	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.12	1.13	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	1.7	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	0	0	0	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	38	38	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	0	0	0	0
WY 2010 (Year 1)	0	1	3	0
WY 2014 (Year 5)	0	14	43	0
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2010 and revegetation planting assumed during Fall WY 2011.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 37
SAM data summary of existing conditions at site Sacramento River RM 114.5R.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	29.2	34.8	33.2	30.7
Wetted Area (square feet) [2]	137,116	146,582	143,601	139,223
Shoreline Length (feet) [2]	1,525	1,523	1,523	1,525
Bank Slope (dH:dV) [2]	0.9	1.0	1.0	0.9
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.55	1.58	1
Bank Substrate Size (D50 in inches) [3]	0.9	0.25	0.25	0.9
Instream Structure (% shoreline) [4]	30	30	30	30
Vegetation (% shoreline) [3]	13	63	63	13
Shade (% shoreline) [5]	73	22	63	76

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 38

SAM data summary of with-project conditions at site Sacramento River RM 114.5R.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	29.2	34.8	33.2	30.7
Wetted Area (square feet)	137,116	146,582	143,601	139,223
Shoreline Length (feet)	1,525	1,523	1,523	1,525
Bank Slope (dH:dV)				
WY 2009 (Year 0)	0.9	1.0	1.0	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.55	1.58	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	0.9	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	30	30	30	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	63	63	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	73	22	63	19
WY 2010 (Year 1)	18	7	19	19
WY 2014 (Year 5)	18	19	56	19
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2010 and revegetation planting assumed during Fall WY 2011.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 41
SAM data summary of existing conditions at site Sacramento River RM 136.7R.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	39.9	45.0	43.8	42.6
Wetted Area (square feet) [2]	46,798	50,334	49,774	49,168
Shoreline Length (feet) [2]	477	309	308	307
Bank Slope (dH:dV) [2]	1.4	1.2	1.2	1.2
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.35	1.36	1
Bank Substrate Size (D50 in inches) [3]	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [4]	1	1	1	1
Vegetation (% shoreline) [3]	13	13	13	13
Shade (% shoreline) [5]	5	13	34	32

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 42
SAM data summary of with-project conditions at site Sacramento River RM 136.7R.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	39.9	45.0	43.8	42.6
Wetted Area (square feet)	46,798	50,334	49,774	49,168
Shoreline Length (feet)	477	309	308	307
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.4	1.2	1.2	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.35	1.36	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	0.25	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	1	1	1	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	13	13	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	5	13	34	8
WY 2010 (Year 1)	1	4	12	8
WY 2014 (Year 5)	1	18	53	8
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2010 and revegetation planting assumed during Fall WY 2011.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 43
SAM data summary of existing conditions at site Sacramento River RM 136.9R.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	40.0	45.1	43.9	42.7
Wetted Area (square feet) [2]	84,317	93,049	90,858	89,207
Shoreline Length (feet) [2]	875	875	874	875
Bank Slope (dH:dV) [2]	1.9	1.7	1.6	1.5
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.31	1.34	1
Bank Substrate Size (D50 in inches) [3]	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [4]	4	4	4	4
Vegetation (% shoreline) [3]	13	13	13	13
Shade (% shoreline) [5]	12	7	17	18

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 44
SAM data summary of with-project conditions at site Sacramento River RM 136.9R.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	40.0	45.1	43.9	42.7
Wetted Area (square feet)	84,317	93,049	90,858	89,207
Shoreline Length (feet)	875	875	874	875
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.9	1.7	1.6	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.31	1.34	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	0.25	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	4	4	4	50
WY 2010-2059	50	50	50	50
Vegetation (% shoreline)				
WY 2009 (Year 0)	13	13	13	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	12	7	17	4
WY 2010 (Year 1)	3	3	8	4
WY 2014 (Year 5)	3	16	48	4
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2010 and revegetation planting assumed during Fall WY 2011.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 45
SAM data summary of existing conditions at site Sutter Bypass LM 0.4E.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet) [1]	38.9	40.9	40.5	39.9
Wetted Area (square feet) [2]	32,921	33,528	33,359	33,141
Shoreline Length (feet) [2]	365	365	365	366
Bank Slope (dH:dV) [2]	1.1	1.0	1.1	1.1
Floodplain Inundation Ratio (AQ2:AQavg) [2]	1	1.31	1.32	1
Bank Substrate Size (D50 in inches) [3]	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [4]	8	8	8	8
Vegetation (% shoreline) [3]	63	63	63	63
Shade (% shoreline) [5]	16	4	12	16

[1] Water surface elevations provided by USACE utilizing nearby stream gauge data and HEC-RAS modelling (NAVD 88 ft datum conversion provided by Kleinfelder).

[2] Attributes developed in GIS by Stillwater Sciences using seasonal water surface elevations and bathymetric and topographic survey data provided by Kleinfelder.

[3] Attribute surveyed by Stillwater Sciences following the field data collection protocol for the USACE riprap database (USFWS 2002, Appendix B USACE 2007a).

[4] Attribute surveyed by North State Resources following the field data collection protocol for the USACE mitigation monitoring plan for riparian and aquatic habitat (USACE 2006c).

[5] Attribute coverage determined from GIS analysis using digitized canopy overlaying seasonal shoreline positions.

Table 46
SAM data summary of with-project conditions at site Sutter Bypass LM 0.4E.

	Seasonal Values			
	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	38.9	40.9	40.5	39.9
Wetted Area (square feet)	32,921	33,528	33,359	33,141
Shoreline Length (feet)	365	365	365	366
Bank Slope (dH:dV)				
WY 2009 (Year 0)	1.1	1.0	1.1	2
WY 2010-2059	2	10	10	2
Floodplain Inundation Ratio (AQ2:AQavg)	1	1.31	1.32	1
Bank Substrate Size (D50 in inches)				
WY 2009 (Year 0)	0.25	0.25	0.25	10
WY 2010-2059	10	0.25	0.25	10
Instream Structure (% shoreline)				
WY 2009 (Year 0)	8	8	8	25
WY 2010-2059	25	25	25	25
Vegetation (% shoreline)				
WY 2009 (Year 0)	63	63	63	0
WY 2010 (Year 1)	0	25	50	0
WY 2014 (Year 5)	0	88	88	0
WY 2024 (Year 15)	0	88	88	0
WY 2034 (Year 25)	0	88	88	0
WY 2059 (Year50)	0	88	88	0
Shade (% shoreline)				
WY 2009 (Year 0)	16	4	12	4
WY 2010 (Year 1)	4	1	3	4
WY 2014 (Year 5)	4	1	3	4
WY 2024 (Year 15)	100	25	75	100
WY 2034 (Year 25)	100	25	75	100
WY 2059 (Year50)	100	25	75	100

WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Summer WY 2009 and revegetation planting assumed during Fall WY 2010.
With-project conditions based on design and construction specifications provided by Kleinfelder.

Table 51
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 26.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-30		-77	-216		-12		26	13		-24		27	74		-59		-156	-434	
WY 2015 (Year 5)	-53		-139	-389		-9		80	121		-21		98	180		-59		-156	-434	
WY 2025 (Year 15)	-32		-138	-403		5		126	231		2		155	237		-34		-144	-420	
WY 2035 (Year 25)	-12		-131	-397		10		141	259		10		169	249		-13		-135	-408	
WY 2060 (Year 50)	3		-125	-393		14		152	280		15		180	258		3		-128	-399	
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-30		-77					26	13		-24			74		-59				
WY 2015 (Year 5)	-53		-139					80	121		21			180		-59				
WY 2025 (Year 15)	-32		-138					126	231		2			237		-34				
WY 2035 (Year 25)	-12		-131					141	259		10			249		-13				
WY 2060 (Year 50)	3		-125					152	280		15			258		3				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-30			-216		-12			13		-24		27							
WY 2015 (Year 5)	-53			-389		-9			121		-21		98							
WY 2025 (Year 15)	-32			-403		5			231		2		155							
WY 2035 (Year 25)	-12			-397		10			259		10		169							
WY 2060 (Year 50)	3			-393		14			280		15		180							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-30		-77	-216		-12		26	13		-24		27	74		-59		-156		
WY 2015 (Year 5)	-53		-139	-389		-9		80	121		-21		98	180		-59		-156		
WY 2025 (Year 15)	-32		-138	-403		5		126	231		2		155	237		-34		-144		
WY 2035 (Year 25)	-12		-131	-397		10		141	259		10		169	249		-13		-135		
WY 2060 (Year 50)	3		-125	-393		14		152	280		15		180	258		3		-128		
Central Valley steelhead																				
WY 2010 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2011 (Year 1)	-44		-105		-44	-26		34	33	-38	-38		31	54	-38	-88		-212		-88
WY 2015 (Year 5)	-79		190		-79	-22		102	114	-34	-34		113	132	-34	-88		-212		-88
WY 2025 (Year 15)	49		-183		-49	6		158	182	1	1		179	176	1	-51		-192		-51
WY 2035 (Year 25)	-21		-169		-21	16		176	200	11	11		196	186	11	-22		-175		-22
WY 2060 (Year 50)	0		-159		0	23		190	214	18	18		208	193	18	-1		-162		-1
Delta Smelt																				
WY 2010 (Year 0)							0	0				0	0				0	0		
WY 2011 (Year 1)							136	136				133	133				-389	-389		
WY 2015 (Year 5)							253	253				240	240				-389	-389		
WY 2025 (Year 15)							280	280				258	258				-389	-389		
WY 2035 (Year 25)							286	286				262	262				-389	-389		
WY 2060 (Year 50)							290	290				264	264				-389	-389		

Notes:

1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River

2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 52
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 35.4L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	46		8	58		47		35	127		48		38	154		93		16	117	
WY 2014 (Year 5)	83		14	105		89		73	274		98		95	326		93		16	117	
WY 2024 (Year 15)	111		30	143		106		103	356		125		143	403		114		31	147	
WY 2034 (Year 25)	129		42	168		113		118	385		136		162	422		131		43	171	
WY 2059 (Year 50)	143		52	187		119		130	407		144		176	437		144		52	189	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	46		8					35	127		48			154		93				
WY 2014 (Year 5)	83		14					73	274		98			326		93				
WY 2024 (Year 15)	111		30					103	356		125			403		114				
WY 2034 (Year 25)	129		42					118	385		136			422		131				
WY 2059 (Year 50)	143		52					130	407		144			437		144				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	46			58		47			127		48		38							
WY 2014 (Year 5)	83			105		89			274		98		95							
WY 2024 (Year 15)	111			143		106			356		125		143							
WY 2034 (Year 25)	129			168		113			385		136		162							
WY 2059 (Year 50)	143			187		119			407		144		176							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	46		8	58		47		35	127		48		38	154		93		16		
WY 2014 (Year 5)	83		14	105		89		73	274		98		95	326		93		16		
WY 2024 (Year 15)	111		30	143		106		103	356		125		143	403		114		31		
WY 2034 (Year 25)	129		42	168		113		118	385		136		162	422		131		43		
WY 2059 (Year 50)	143		52	187		119		130	407		144		176	437		144		52		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	93		18		93	94		57	115	97	97		61	129	97	185		35		185
WY 2014 (Year 5)	167		32		167	180		116	232	197	197		144	266	197	185		35		185
WY 2024 (Year 15)	215		58		215	214		156	288	245	245		203	325	245	221		59		221
WY 2034 (Year 25)	245		77		245	228		175	309	262	262		226	342	262	250		78		250
WY 2059 (Year 50)	269		92		269	238		189	325	275	275		243	355	275	271		93		271
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							162	162				167	167				47	47		
WY 2014 (Year 5)							296	296				301	301				47	47		
WY 2024 (Year 15)							323	323				323	323				47	47		
WY 2034 (Year 25)							328	328				328	328				47	47		
WY 2059 (Year 50)							332	332				331	331				47	47		

Notes:

1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River

2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 53
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 41.9R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-22		-91	-221		-10		14	-15		-19		5	15		-46		-163	-409	
WY 2015 (Year 5)	-39		-164	-398		-8		49	48		-16		51	69		-46		-163	-409	
WY 2025 (Year 15)	-19		-165	-408		3		84	130		4		97	114		-23		-152	-391	
WY 2035 (Year 25)	-1		-159	-399		7		96	151		10		109	124		-5		-143	-377	
WY 2060 (Year 50)	13		-154	-391		11		105	168		15		118	131		9		-137	-366	
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-22		-91					14	-15		-19			15		-46				
WY 2015 (Year 5)	-39		-164					49	48		-16			69		-46				
WY 2025 (Year 15)	-19		-165					84	130		4			114		-23				
WY 2035 (Year 25)	-1		-159					96	151		10			124		-5				
WY 2060 (Year 50)	13		-154					105	168		15			131		9				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-22			-221		-10			-15		-19		5							
WY 2015 (Year 5)	-39			-398		-8			48		-16		51							
WY 2025 (Year 15)	-19			-408		3			130		4		97							
WY 2035 (Year 25)	-1			-399		7			151		10		109							
WY 2060 (Year 50)	13			-391		11			168		15		118							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-22		-91	-221		-10		14	-15		-19		5	15		-46		-163		
WY 2015 (Year 5)	-39		-164	-398		8		49	48		-16		51	69		-46		-163		
WY 2025 (Year 15)	-19		-165	-408		3		84	130		4		97	114		-23		-152		
WY 2035 (Year 25)	-1		-159	-399		7		96	151		10		109	124		-5		-143		
WY 2060 (Year 50)	13		-154	-391		11		105	168		15		118	131		9		-137		
Central Valley steelhead																				
WY 2010 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2011 (Year 1)	-38		-120		-38	-20		17	16	-32	-32		5	22	-32	-78		-218		-78
WY 2015 (Year 5)	69		-216		-69	-16		61	71	-28	-28		56	72	-28	-78		-218		-78
WY 2025 (Year 15)	-38		-212		-38	7		104	123	2	2		110	109	2	-44		-198		-44
WY 2035 (Year 25)	-11		-199		-11	15		118	138	11	11		124	117	11	-17		-183		-17
WY 2060 (Year 50)	10		-189		10	21		129	149	17	17		134	123	17	4		-171		4
Delta Smelt																				
WY 2010 (Year 0)							0	0				0	0				0	0		
WY 2011 (Year 1)							85	85				84	84				-365	-365		
WY 2015 (Year 5)							159	159				151	151				-365	-365		
WY 2025 (Year 15)							177	177				163	163				-365	-365		
WY 2035 (Year 25)							180	180				165	165				-365	-365		
WY 2060 (Year 50)							183	183				167	167				-365	-365		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 54
SAM results showing bankline weighted relative response (feet) at Lower American River RM 10.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	5		0	16		12		14	32		7		22	66		10		6	48	
WY 2014 (Year 5)	10		0	29		26		39	95		22		57	135		10		6	48	
WY 2024 (Year 15)	20		6	39		34		57	139		32		79	159		19		12	54	
WY 2034 (Year 25)	29		11	45		36		62	150		35		84	164		27		16	59	
WY 2059 (Year 50)	35		15	50		37		66	157		37		88	168		33		19	62	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	5		0					14	32		7			66		10				
WY 2014 (Year 5)	10		0					39	95		22			135		10				
WY 2024 (Year 15)	20		6					57	139		32			159		19				
WY 2034 (Year 25)	29		11					62	150		35			164		27				
WY 2059 (Year 50)	35		15					66	157		37			168		33				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	5			16		12			32		7		22							
WY 2014 (Year 5)	10			29		26			95		22		57							
WY 2024 (Year 15)	20			39		34			139		32		79							
WY 2034 (Year 25)	29			45		36			150		35		84							
WY 2059 (Year 50)	35			50		37			157		37		88							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	5		0	16		12		14	32		7		22	66		10		6		
WY 2014 (Year 5)	10		0	29		26		39	95		22		57	135		10		6		
WY 2024 (Year 15)	20		6	39		34		57	139		32		79	159		19		12		
WY 2034 (Year 25)	29		11	45		36		62	150		35		84	164		27		16		
WY 2059 (Year 50)	35		15	50		37		66	157		37		88	168		33		19		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	20		1		20	26		19	27	23	23		27	43	23	42		11		42
WY 2014 (Year 5)	36		1		36	58		52	69	55	55		70	90	55	42		11		42
WY 2024 (Year 15)	53		11		53	73		74	97	72	72		96	109	72	55		19		55
WY 2034 (Year 25)	65		19		65	77		80	103	76	76		102	113	76	65		26		65
WY 2059 (Year 50)	74		25		74	80		85	108	79	79		106	116	79	73		32		73
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							57	57				69	69				54	54		
WY 2014 (Year 5)							105	105				124	124				54	54		
WY 2024 (Year 15)							116	116				133	133				54	54		
WY 2034 (Year 25)							119	119				135	135				54	54		
WY 2059 (Year 50)							120	120				136	136				54	54		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 55
SAM results showing bankline weighted relative response (feet) at Lower American River RM 10.6L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-8		-24	-32		-2		3	-9		-7		9	24		-17		-35	-43	
WY 2014 (Year 5)	-14		-42	-58		0		16	15		-6		32	58		-17		-35	-43	
WY 2024 (Year 15)	-6		-39	-56		5		33	52		1		52	75		-9		-30	-38	
WY 2034 (Year 25)	2		-35	-51		7		40	63		4		57	79		-2		-26	-34	
WY 2059 (Year 50)	7		-32	-47		9		46	71		6		61	81		3		-23	-32	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-8		-24					3	-9		-7			24		-17				
WY 2014 (Year 5)	-14		-42					16	15		-6			58		-17				
WY 2024 (Year 15)	-6		-39					33	52		1			75		-9				
WY 2034 (Year 25)	2		-35					40	63		4			79		-2				
WY 2059 (Year 50)	7		-32					46	71		6			81		3				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-8			-32		-2			-9		-7		9							
WY 2014 (Year 5)	-14			-58		0			15		-6		32							
WY 2024 (Year 15)	-6			-56		5			52		1		52							
WY 2034 (Year 25)	2			-51		7			63		4		57							
WY 2059 (Year 50)	7			-47		9			71		6		61							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-8		-24	-32		-2		3	-9		-7		9	24		-17		-35		
WY 2014 (Year 5)	-14		-42	-58		0		16	15		-6		32	58		-17		-35		
WY 2024 (Year 15)	-6		-39	-56		5		33	52		1		52	75		-9		-30		
WY 2034 (Year 25)	2		-35	-51		7		40	63		4		57	79		-2		-26		
WY 2059 (Year 50)	7		-32	-47		9		46	71		6		61	81		3		-23		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	-11		-31		-11	-4		4	1	-9	-9		11	18	-9	-20		-47		-20
WY 2014 (Year 5)	-21		-56		-21	-1		21	19	-6	-6		37	42	-6	-20		-47		-20
WY 2024 (Year 15)	-8		-51		-8	10		41	42	5	5		58	56	5	-9		-40		-9
WY 2034 (Year 25)	3		-44		3	14		49	49	8	8		64	59	8	0		-34		0
WY 2059 (Year 50)	11		-39		11	17		55	54	11	11		69	62	11	7		-29		7
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							28	28				42	42				-92	-92		
WY 2014 (Year 5)							53	53				75	75				-92	-92		
WY 2024 (Year 15)							60	60				80	80				-92	-92		
WY 2034 (Year 25)							62	62				82	82				-92	-92		
WY 2059 (Year 50)							63	63				82	82				-92	-92		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 56
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 71.3R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-4		-12	-22		0		9	11		-3		11	28		-8		-23	-43	
WY 2015 (Year 5)	-7		-21	-40		3		25	44		1		33	63		-8		-23	-43	
WY 2025 (Year 15)	-1		-20	-39		7		36	72		8		49	80		-1		-20	-39	
WY 2035 (Year 25)	4		-17	-36		9		40	79		10		53	83		4		-17	-35	
WY 2060 (Year 50)	8		-16	-34		10		43	85		11		56	86		8		-15	-33	
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-4		-12					9	11		-3			28		-8				
WY 2015 (Year 5)	-7		-21					25	44		1			63		-8				
WY 2025 (Year 15)	-1		-20					36	72		8			80		-1				
WY 2035 (Year 25)	4		-17					40	79		10			83		4				
WY 2060 (Year 50)	8		-16					43	85		11			86		8				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-4			-22		0			11		-3		11							
WY 2015 (Year 5)	-7			-40		3			44		1		33							
WY 2025 (Year 15)	-1			-39		7			72		8		49							
WY 2035 (Year 25)	4			-36		9			79		10		53							
WY 2060 (Year 50)	8			-34		10			85		11		56							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-4		-12	-22		0		9	11		-3		11	28		-8		-23		
WY 2015 (Year 5)	-7		-21	-40		3		25	44		1		33	63		-8		-23		
WY 2025 (Year 15)	-1		-20	-39		7		36	72		8		49	80		-1		-20		
WY 2035 (Year 25)	4		-17	-36		9		40	79		10		53	83		4		-17		
WY 2060 (Year 50)	8		-16	-34		10		43	85		11		56	86		8		-15		
Central Valley steelhead																				
WY 2010 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2011 (Year 1)	-4		-16		-4	0		12	13	-3	-3		14	20	-3	-8		-32		-8
WY 2015 (Year 5)	-8		-29		-8	7		32	36	5	5		40	45	5	-8		-32		-8
WY 2025 (Year 15)	2		-26		2	15		47	54	15	15		59	58	15	1		-26		1
WY 2035 (Year 25)	9		-22		9	17		52	59	18	18		63	60	18	9		-22		9
WY 2060 (Year 50)	15		-19		15	19		55	62	20	20		67	62	20	15		-18		15
Delta Smelt																				
WY 2010 (Year 0)							0	0				0	0				0	0		
WY 2011 (Year 1)							37	37				40	40				-62	-62		
WY 2015 (Year 5)							68	68				71	71				-67	-62		
WY 2025 (Year 15)							76	76				77	77				-62	-62		
WY 2035 (Year 25)							77	77				78	78				-62	-62		
WY 2060 (Year 50)							78	78				78	78				-62	-62		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 57
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 73.5L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-11		-35	-72		-2		17	16		-8		9	31		-22		-73	-149	
WY 2014 (Year 5)	-19		-62	-130		2		47	80		-2		47	86		-22		-73	-149	
WY 2024 (Year 15)	-4		-59	-127		11		73	141		13		82	121		-6		-66	-136	
WY 2034 (Year 25)	8		-54	-118		14		82	157		18		91	128		7		-60	-126	
WY 2059 (Year 50)	18		-50	-112		16		89	169		21		97	134		17		-55	-118	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-11		-35					17	16		-8			31		-22				
WY 2014 (Year 5)	-19		-62					47	80		-2			86		-22				
WY 2024 (Year 15)	-4		-59					73	141		13			121		-6				
WY 2034 (Year 25)	8		-54					82	157		18			128		7				
WY 2059 (Year 50)	18		-50					89	169		21			134		17				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-11			-72		-2			16		-8		9							
WY 2014 (Year 5)	19			-130		2			80		-2		47							
WY 2024 (Year 15)	-4			-127		11			141		13		82							
WY 2034 (Year 25)	8			-118		14			157		18		91							
WY 2059 (Year 50)	18			-112		16			169		21		97							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-11		-35	-72		-2		17	16		-8		9	31		-22		-73		
WY 2014 (Year 5)	-19		-62	-130		2		47	80		-2		47	86		-22		-73		
WY 2024 (Year 15)	-4		-59	-127		11		73	141		13		82	121		-6		-66		
WY 2034 (Year 25)	8		-54	-118		14		82	157		18		91	128		7		-60		
WY 2059 (Year 50)	18		-50	-112		16		89	169		21		97	134		17		-55		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	-18		-46		-18	-6		22	22	-13	-13		12	20	-13	-36		-100		-36
WY 2014 (Year 5)	-32		-86		-32	3		62	69	-3	-3		55	60	-3	-36		-100		-36
WY 2024 (Year 15)	-10		-78		-10	20		93	107	20	20		96	87	20	-12		-86		-17
WY 2034 (Year 25)	9		-68		9	26		104	117	26	26		106	93	26	7		-75		7
WY 2059 (Year 50)	23		-61		23	30		112	125	31	31		114	98	31	21		-67		21
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							71	71				59	59				-179	-179		
WY 2014 (Year 5)							132	132				107	107				-179	-179		
WY 2024 (Year 15)							146	146				115	115				-179	-179		
WY 2034 (Year 25)							149	149				117	117				-179	-179		
WY 2059 (Year 50)							151	151				118	118				-179	-179		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 58
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 78.8L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-3		-6	-14		-1		5	15		-3		6	23		-7		-12	-28	
WY 2014 (Year 5)	-6		-11	-25		0		13	39		-2		17	48		-7		-12	-28	
WY 2024 (Year 15)	-2		-10	-24		2		19	55		2		26	58		-3		-10	25	
WY 2034 (Year 25)	1		-8	-22		2		21	59		3		28	61		0		9	-22	
WY 2059 (Year 50)	3		-7	-20		3		23	62		4		30	62		2		-8	-21	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-3		-6					5	15		-3			23		-7				
WY 2014 (Year 5)	-6		-11					13	39		-2			48		-7				
WY 2024 (Year 15)	-2		-10					19	55		2			58		-3				
WY 2034 (Year 25)	1		-8					21	59		3			61		0				
WY 2059 (Year 50)	3		-7					23	62		4			62		2				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-3			-14		-1			15		-3		6							
WY 2014 (Year 5)	-6			-25		0			39		-2		17							
WY 2024 (Year 15)	-2			-24		2			55		2		26							
WY 2034 (Year 25)	1			-22		2			59		3		28							
WY 2059 (Year 50)	3			-20		3			62		4		30							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-3		-6	-14		-1		5	15		-3		6	23		-7		-12		
WY 2014 (Year 5)	-6		-11	-25		0		13	39		-2		17	48		-7		-12		
WY 2024 (Year 15)	-2		-10	-24		2		19	55		2		26	58		-3		-10		
WY 2034 (Year 25)	1		-8	-22		2		21	59		3		28	61		0		-9		
WY 2059 (Year 50)	3		-7	-20		3		23	62		4		30	62		2		-8		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	-6		-9		-6	-2		7	13	-4	-4		7	15	-4	-11		-17		-11
WY 2014 (Year 5)	-10		-15		-10	-1		17	29	-3	-3		21	33	-3	-11		-17		-11
WY 2024 (Year 15)	-5		-13		-5	3		25	39	2	2		31	41	2	-6		-14		-6
WY 2034 (Year 25)	0		-11		0	4		28	42	4	4		34	43	4	-1		-12		-1
WY 2059 (Year 50)	3		-9		3	5		30	44	5	5		36	44	5	2		-10		2
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							24	24				26	26				-29	-29		
WY 2014 (Year 5)							45	45				47	47				-29	-29		
WY 2024 (Year 15)							49	49				51	51				-29	-29		
WY 2034 (Year 25)							50	50				51	51				-29	-29		
WY 2059 (Year 50)							51	51				52	52				-29	-29		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 61
SAM results showing bankline weighted relative response (feet) at Feather River RM 5.5L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-1		-4			0		14	16		-5		15	37		-3		-6		
WY 2014 (Year 5)	-3		-8			5		38	68		1		49	90		-3		-6		
WY 2024 (Year 15)	13		6			12		58	117		13		76	120		12		8		
WY 2034 (Year 25)	25		17			15		65	130		17		83	127		25		20		
WY 2059 (Year 50)	34		25			17		71	141		20		89	131		34		28		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-1		-4					14	16		-5			37		-3				
WY 2014 (Year 5)	-3		-8					38	68		1			90		3				
WY 2024 (Year 15)	13		-6					58	117		13			120		12				
WY 2034 (Year 25)	25		17					65	130		17			127		25				
WY 2059 (Year 50)	34		25					71	141		20			131		34				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-1			-9		0			16		-5		15							
WY 2014 (Year 5)	-3			-16		5			68		-1		49							
WY 2024 (Year 15)	13			4		12			117		13		76							
WY 2034 (Year 25)	25			20		15			130		17		83							
WY 2059 (Year 50)	34			32		17			141		20		89							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-1		-4	-9		0		14	16		-5		15	37		-3		-6	-10	
WY 2014 (Year 5)	-3		-8	-16		5		38	68		1		49	90		-3		-6	-10	
WY 2024 (Year 15)	13		6	4		12		58	117		13		76	120		12		8	10	
WY 2034 (Year 25)	25		17	20		15		65	130		17		83	127		25		20	27	
WY 2059 (Year 50)	34		25	32		17		71	141		20		89	131		34		28	39	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	-4		-7	-12	-4	-1		19	19	-7			18	25	-7	-7		-9	-17	-7
WY 2014 (Year 5)	-7		-12	-21	-7	9		50	56	3			59	63	3	-7		-9	-17	-7
WY 2024 (Year 15)	17		7	2	17	23		75	86	21			91	86	21	17		11	4	17
WY 2034 (Year 25)	37		24	14	37	29		84	95	27			100	91	27	37		28	20	37
WY 2059 (Year 50)	52		36	26	52	33		91	102	31			106	95	31	52		40	32	52

Notes:

1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River

2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 62
SAM results showing bankline weighted relative response (feet) at Feather River RM 7.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	22		-2			25		20	57		24		25	73		43		-5		
WY 2014 (Year 5)	39		-4			50		51	138		53		66	152		43		-5		
WY 2024 (Year 15)	53		0			59		69	181		66		91	183		53		-1		
WY 2034 (Year 25)	62		3			61		73	190		69		96	189		62		3		
WY 2059 (Year 50)	69		5			63		76	197		71		100	194		68		5		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	22		-2					20	57		24			73		43				
WY 2014 (Year 5)	39		-4					51	138		53			152		43				
WY 2024 (Year 15)	53		0					69	181		66			183		53				
WY 2034 (Year 25)	62		3					73	190		69			189		62				
WY 2059 (Year 50)	69		5					76	197		71			194		68				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	22			-9		25			57		24		25							
WY 2014 (Year 5)	39			-16		50			138		53		66							
WY 2024 (Year 15)	53			-7		59			181		66		91							
WY 2034 (Year 25)	62			0		61			190		69		96							
WY 2059 (Year 50)	69			6		63			197		71		100							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	22		-2	-9		25		20	57		24		25	73		43		-5	-18	
WY 2014 (Year 5)	39		-4	-16		50		51	138		53		66	152		43		-5	-18	
WY 2024 (Year 15)	53		0	-7		59		69	181		66		91	183		53		-1	-8	
WY 2034 (Year 25)	62		3	0		61		73	190		69		96	189		62		3	-1	
WY 2059 (Year 50)	69		5	6		63		76	197		71		100	194		68		5	5	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	45		-4	-9	45	50		31	53	49			35	59	49	88		-8	-17	88
WY 2014 (Year 5)	81		-7	16	81	101		73	117	104			88	123	104	88		-8	-17	88
WY 2024 (Year 15)	104		1	-5	104	119		96	145	127			118	147	127	105		0	-6	105
WY 2034 (Year 25)	119		7	4	119	123		101	151	131			124	152	131	118		6	3	118
WY 2059 (Year 50)	130		11	11	130	126		104	156	135			129	156	135	128		10	9	128

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 63
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 87.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	29		-1			30		23	62		30		26	79		57		-3		
WY 2014 (Year 5)	52		-2			59		55	153		66		74	178		57		-3		
WY 2024 (Year 15)	71		5			70		78	209		84		110	226		72		4		
WY 2034 (Year 25)	83		11			74		86	224		90		120	236		84		10		
WY 2059 (Year 50)	93		15			77		93	236		94		127	244		93		15		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	29		-1					23	62		30			79		57				
WY 2014 (Year 5)	52		-2					55	153		66			178		57				
WY 2024 (Year 15)	71		5					78	209		84			226		72				
WY 2034 (Year 25)	83		11					86	224		90			236		84				
WY 2059 (Year 50)	93		15					93	236		94			244		93				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	29			-14		30			62		30		26							
WY 2014 (Year 5)	52			-25		59			153		66		74							
WY 2024 (Year 15)	71			-9		70			209		84		110							
WY 2034 (Year 25)	83			5		74			224		90		120							
WY 2059 (Year 50)	93			15		77			236		94		127							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	29		-1	-14		30		23	62		30		26	79		57		-3	-31	
WY 2014 (Year 5)	52		-2	-25		59		55	153		66		74	178		57		-3	-31	
WY 2024 (Year 15)	71		5	-9		70		78	209		84		110	226		72		4	-13	
WY 2034 (Year 25)	83		11	5		74		86	224		90		120	236		84		10	1	
WY 2059 (Year 50)	93		15	15		77		93	236		94		127	244		93		15	11	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	59		0	-12	59	61		35	58	62			38	64	62	116		-2	-26	116
WY 2014 (Year 5)	105		-1	-21	105	120		80	128	132			102	142	132	116		-2	-26	116
WY 2024 (Year 15)	138		13	-3	138	143		110	164	164			145	178	164	141		12	-7	141
WY 2034 (Year 25)	159		24	11	159	151		120	175	173			157	187	173	161		23	6	161
WY 2059 (Year 50)	175		32	23	175	156		128	184	180			166	193	180	175		31	19	175

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 64
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 93.7L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	40		2			41		30	94		43		34	121		81		4		
WY 2014 (Year 5)	73		3			81		69	218		90		95	263		81		4		
WY 2024 (Year 15)	96		12			95		97	289		114		138	326		99		13		
WY 2034 (Year 25)	112		19			100		107	308		121		150	340		114		20		
WY 2059 (Year 50)	124		25			104		115	323		126		159	350		125		26		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	40		2					30	94		43			121		81				
WY 2014 (Year 5)	73		3					69	218		90			263		81				
WY 2024 (Year 15)	96		12					97	289		114			326		99				
WY 2034 (Year 25)	112		19					107	308		121			340		114				
WY 2059 (Year 50)	124		25					115	323		126			350		125				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	40			14		41			94		43		34							
WY 2014 (Year 5)	73			26		81			218		90		95							
WY 2024 (Year 15)	96			50		95			289		114		138							
WY 2034 (Year 25)	112			68		100			308		121		150							
WY 2059 (Year 50)	124			81		104			323		126		159							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	40		2	14		41		30	94		43		34	121		81		4	33	
WY 2014 (Year 5)	73		3	26		81		69	218		90		95	263		81		4	33	
WY 2024 (Year 15)	96		12	50		95		97	289		114		138	326		99		13	55	
WY 2034 (Year 25)	112		19	68		100		107	308		121		150	340		114		20	73	
WY 2059 (Year 50)	124		25	81		104		115	323		126		159	350		125		26	86	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	80		5	13	80	82		47	85	85			52	99	85	161		13	32	161
WY 2014 (Year 5)	145		10	24	145	161		104	181	179			134	212	179	161		13	32	161
WY 2024 (Year 15)	186		27	49	186	191		139	226	220			187	260	220	191		30	55	191
WY 2034 (Year 25)	212		41	68	212	201		152	247	231			207	271	231	215		43	73	215
WY 2059 (Year 50)	232		51	82	232	208		162	252	240			213	280	240	233		53	87	233

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 65
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 114.5R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-18		-33			-6		31	29		-15		45	92		-36		-65		
WY 2014 (Year 5)	-32		-59			-2		83	126		-11		121	199		-36		-65		
WY 2024 (Year 15)	-15		-55			8		124	212		6		173	244		-17		-57		
WY 2034 (Year 25)	0		-49			12		137	234		11		186	254		-2		-50		
WY 2059 (Year 50)	11		-45			15		148	250		15		196	261		9		-45		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-18		-33					31	29		-15			92		-36				
WY 2014 (Year 5)	-32		-59					83	126		-11			199		-36				
WY 2024 (Year 15)	-15		-55					124	212		6			244		-17				
WY 2034 (Year 25)	0		-49					137	234		11			254		-2				
WY 2059 (Year 50)	11		-45					148	250		15			261		9				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-18			-63		-6			29		-15		45							
WY 2014 (Year 5)	-32			-114		-2			126		-11		121							
WY 2024 (Year 15)	-15			-112		8			212		6		173							
WY 2034 (Year 25)	0			-105		12			234		11		186							
WY 2059 (Year 50)	11			-100		15			250		15		196							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-18		-33	-63		-6		31	29		-15		45	92		-36		-65	-125	
WY 2014 (Year 5)	-32		-59	-114		-2		83	126		-11		121	199		-36		-65	-125	
WY 2024 (Year 15)	-15		-55	-112		8		124	212		6		173	244		-17		-57	-115	
WY 2034 (Year 25)	0		-49	-105		12		137	234		11		186	254		-2		50	-107	
WY 2059 (Year 50)	11		-45	-100		15		148	250		15		196	261		9		-45	-101	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	-24		-46	-65	-24	-13		39	36	-20			51	64	-20	-46		-91	-129	-46
WY 2014 (Year 5)	-42		-82	-118	-42	-6		103	105	-11			138	139	-11	-46		-91	-129	-46
WY 2024 (Year 15)	-19		-73	-112	-19	15		151	157	14			195	174	14	-20		-76	-115	-20
WY 2034 (Year 25)	2		-62	-102	2	22		167	171	21			210	181	21	1		64	-104	1
WY 2059 (Year 50)	18		-54	-95	18	28		179	182	26			221	187	26	17		-55	-96	17

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 66
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 130.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	12		0			16		14	38		14		17	49		24		1		
WY 2015 (Year 5)	22		1			31		34	93		31		45	105		24		1		
WY 2025 (Year 15)	32		5			38		48	126		41		65	130		32		5		
WY 2035 (Year 25)	39		8			40		53	135		44		70	135		38		8		
WY 2060 (Year 50)	44		10			42		56	142		46		74	138		43		10		
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	12		0					14	38		14			49		24				
WY 2015 (Year 5)	22		1					34	93		31			105		24				
WY 2025 (Year 15)	32		5					48	126		41			130		32				
WY 2035 (Year 25)	39		8					53	135		44			135		38				
WY 2060 (Year 50)	44		10					56	142		46			138		43				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	12			11		16			38		14		17							
WY 2015 (Year 5)	22			20		31			93		31		45							
WY 2025 (Year 15)	32			29		38			126		41		65							
WY 2035 (Year 25)	39			35		40			135		44		70							
WY 2060 (Year 50)	44			40		42			142		46		74							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	12		0	11		16		14	38		14		17	49		24		1	22	
WY 2015 (Year 5)	22		1	20		31		34	93		31		45	105		24		1	22	
WY 2025 (Year 15)	32		5	29		38		48	126		41		65	130		32		5	29	
WY 2035 (Year 25)	39		8	35		40		53	135		44		70	135		38		8	35	
WY 2060 (Year 50)	44		10	40		42		56	142		46		74	138		43		10	39	
Central Valley steelhead																				
WY 2010 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2011 (Year 1)	28		2	7	28	33		21	33	30			23	36	30	54		5	14	54
WY 2015 (Year 5)	50		4	13	50	65		49	74	65			60	79	65	54		5	14	54
WY 2025 (Year 15)	66		12	22	66	79		66	95	82			83	97	82	66		12	22	66
WY 2035 (Year 25)	77		17	29	77	83		72	101	86			89	101	86	76		17	29	76
WY 2060 (Year 50)	85		22	34	85	86		76	106	90			94	104	90	83		21	34	83

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 67
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 136.7R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	19		0			12		12	36		10		14	46		20		-2		
WY 2014 (Year 5)	35		0			23		27	81		23		36	93		20		-2		
WY 2024 (Year 15)	47		5			27		36	104		29		49	109		25		0		
WY 2034 (Year 25)	54		9			29		39	109		31		52	112		29		2		
WY 2059 (Year 50)	60		12			30		41	114		32		55	115		32		4		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	19		0					12	36		10			46		20				
WY 2014 (Year 5)	35		0					27	81		23			93		20				
WY 2024 (Year 15)	47		5					36	104		29			109		25				
WY 2034 (Year 25)	54		9					39	109		31			112		29				
WY 2059 (Year 50)	60		12					41	114		32			115		32				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	19			4		12			36		10		14							
WY 2014 (Year 5)	35			7		23			81		23		36							
WY 2024 (Year 15)	47			19		27			104		29		49							
WY 2034 (Year 25)	54			28		29			109		31		52							
WY 2059 (Year 50)	60			34		30			114		32		55							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	19		0	4		12		12	36		10		14	46		20		-2	1	
WY 2014 (Year 5)	35		0	7		23		27	81		23		36	93		20		-2	1	
WY 2024 (Year 15)	47		5	19		27		36	104		29		49	109		25		0	6	
WY 2034 (Year 25)	54		9	28		29		39	109		31		52	112		29		2	9	
WY 2059 (Year 50)	60		12	34		30		41	114		32		55	115		32		4	12	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	39		2	4	39	24		17	31	23			20	35	23	43		-2	-1	43
WY 2014 (Year 5)	70		3	6	70	47		38	65	47			47	70	47	43		-2	-1	43
WY 2024 (Year 15)	90		12	19	90	56		50	80	58			62	82	58	50		3	4	50
WY 2034 (Year 25)	103		19	28	103	58		53	83	60			66	85	60	57		7	8	57
WY 2059 (Year 50)	113		24	35	113	60		56	86	62			69	87	62	61		9	12	61

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 68
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 136.9R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	25		-4			27		29	92		25		34	115		46		-8		
WY 2014 (Year 5)	45		-7			54		68	210		57		93	242		46		-8		
WY 2024 (Year 15)	64		0			66		95	275		75		133	293		62		-1		
WY 2034 (Year 25)	78		7			70		104	293		81		144	304		74		6		
WY 2059 (Year 50)	88		11			72		111	305		85		152	312		84		10		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	25		-4					29	92		25			115		46				
WY 2014 (Year 5)	45		-7					68	210		57			242		46				
WY 2024 (Year 15)	64		0					95	275		75			293		62				
WY 2034 (Year 25)	78		7					104	293		81			304		74				
WY 2059 (Year 50)	88		11					111	305		85			312		84				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	25			-11		27			92		25		34							
WY 2014 (Year 5)	45			-19		54			210		57		93							
WY 2024 (Year 15)	64			-2		66			275		75		133							
WY 2034 (Year 25)	78			12		70			293		81		144							
WY 2059 (Year 50)	88			22		72			305		85		152							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	25		-4	-11		27		29	92		25		34	115		46		-8	-19	
WY 2014 (Year 5)	45		-7	-19		54		68	210		57		93	242		46		-8	-19	
WY 2024 (Year 15)	64		0	-2		66		95	275		75		133	293		62		-1	-3	
WY 2034 (Year 25)	78		7	12		70		104	293		81		144	304		74		6	10	
WY 2059 (Year 50)	88		11	22		72		111	305		85		152	312		84		10	20	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	53		-5	-12	53	57		43	77	54			48	86	54	99		-10	-22	99
WY 2014 (Year 5)	95		-9	-22	95	113		97	164	118			123	161	118	99		-10	-22	99
WY 2024 (Year 15)	128		6	-4	128	137		130	206	150			171	220	150	125		4	-4	125
WY 2034 (Year 25)	151		18	12	151	145		147	218	158			183	229	158	145		16	10	145
WY 2059 (Year 50)	168		26	23	168	150		150	227	165			193	235	165	160		24	21	160

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 69
SAM results showing bankline weighted relative response (feet) at Sutter Bypass RM 0.4E.

Focus Fish Species and Scenario	Fall (September-November) Adult Upstream Migration	Fall Spawning and Incubation	Fall Juvenile Rearing	Fall Smolt Outmigration	Fall Adult Habitat	Winter (December-February) Adult Upstream Migration	Winter Spawning and Incubation	Winter Juvenile Rearing	Winter Smolt Outmigration	Winter Adult Habitat	Spring (March-May) Adult Upstream Migration	Spring Spawning and Incubation	Spring Juvenile Rearing	Spring Smolt Outmigration	Spring Adult Habitat	Summer (June-August) Adult Upstream Migration	Summer Spawning and Incubation	Summer Juvenile Rearing	Summer Smolt Outmigration	Summer Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	5		-3			6		9	19		5		8	23		9		-6		
WY 2014 (Year 5)	8		-6			11		16	41		9		15	43		9		-6		
WY 2024 (Year 15)	16		-3			16		25	64		16		29	61		16		-3		
WY 2034 (Year 25)	21		-1			18		31	76		21		39	73		21		-1		
WY 2059 (Year 50)	25		-1			20		36	85		25		47	82		25		1		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	5		-3					9	19		5			23		9				
WY 2014 (Year 5)	8		-6					16	41		9			43		9				
WY 2024 (Year 15)	16		-3					25	64		16			61		16				
WY 2034 (Year 25)	21		-1					31	76		21			73		21				
WY 2059 (Year 50)	25		1					36	85		25			82		25				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	5			-22		6			19		5		8							
WY 2014 (Year 5)	8			-40		11			41		9		15							
WY 2024 (Year 15)	16			-36		16			64		16		29							
WY 2034 (Year 25)	21			-31		18			76		21		39							
WY 2059 (Year 50)	25			-28		20			85		25		47							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	5		-3	-22		6		9	19		5		8	23		9		-6	-44	
WY 2014 (Year 5)	8		-6	-40		11		16	41		9		15	43		9		-6	-44	
WY 2024 (Year 15)	16		-3	-36		16		25	64		16		29	61		16		-3	-37	
WY 2034 (Year 25)	21		-1	-31		18		31	76		21		39	73		21		-1	-32	
WY 2059 (Year 50)	25		1	-28		20		36	85		25		47	82		25		1	-28	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	11		-5	-16	11	14		13	21	12			12	21	12	22		-9	-32	22
WY 2014 (Year 5)	20		-9	-29	70	25		23	40	21			22	39	21	22		-9	-32	22
WY 2024 (Year 15)	31		-4	-24	31	33		35	56	33			39	54	33	32		-4	-25	32
WY 2034 (Year 25)	40		0	-18	40	39		43	65	41			51	64	41	41		0	-19	41
WY 2059 (Year 50)	46		3	-14	46	43		49	71	48			60	71	48	47		3	-14	47

Notes:

1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River

2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 70
SAM results showing bankline weighted relative response (feet) at Sacramento River RM 157.7R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-10		-22			-2		25	37		-8		33	79		-21		-45		
WY 2015 (Year 5)	-19		-40			3		66	119		-3		92	167		-21		-45		
WY 2025 (Year 15)	-7		-37			11		97	183		9		132	203		-8		-39		
WY 2035 (Year 25)	3		-33			14		108	199		14		143	210		2		-35		
WY 2060 (Year 50)	10		-31			16		117	212		17		150	216		10		-31		
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-10		-22					25	37		-8			79		-21				
WY 2015 (Year 5)	-19		-40					66	119		-3			167		-21				
WY 2025 (Year 15)	-7		-37					97	183		9			203		-8				
WY 2035 (Year 25)	3		-33					108	199		14			210		2				
WY 2060 (Year 50)	10		-31					117	212		17			216		10				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-10			-41		-2			37		-8		33							
WY 2015 (Year 5)	-19			-74		3			119		-3		92							
WY 2025 (Year 15)	-7			-73		11			183		9		132							
WY 2035 (Year 25)	3			-68		14			199		14		143							
WY 2060 (Year 50)	10			-65		16			212		17		150							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-10		-22	-41		-2		25	37		-8		33	79		-21		-45	-82	
WY 2015 (Year 5)	-19		-40	-74		3		66	119		-3		92	167		-21		-45	-82	
WY 2025 (Year 15)	-7		-37	-73		11		97	183		9		132	203		8		-39	-76	
WY 2035 (Year 25)	3		-33	-68		14		108	199		14		143	210		2		-35	-70	
WY 2060 (Year 50)	10		-31	-65		16		117	212		17		150	216		10		-31	-66	
Central Valley steelhead																				
WY 2010 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2011 (Year 1)	-11		-31	-44	-11	-3		32	32	-9			39	49	-9	-23		-61	88	-23
WY 2015 (Year 5)	-20		-55	-79	-20	6		81	85	1			104	107	1	-23		-61	-88	-23
WY 2025 (Year 15)	-4		-49	-76	-4	22		119	124	20			149	133	20	5		-51	-79	-5
WY 2035 (Year 25)	10		-42	-70	10	27		131	135	25			160	139	25	10		-43	-72	10
WY 2060 (Year 50)	21		-36	-65	21	31		141	143	29			169	143	29	20		-37	-66	20

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 73
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 26.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-4,180		-10,877	-30,416		-1,753		3,820	1,837		-3,468		3,873	10,665		8,381		-22,001	-61,278	
WY 2015 (Year 5)	-7,523		-19,578	-54,749		-1,363		11,596	17,533		-3,022		14,033	25,849		-8,381		-22,001	-61,278	
WY 2025 (Year 15)	-4,447		-19,395	-56,758		727		18,203	33,415		350		22,245	34,025		-4,740		-20,364	-59,227	
WY 2035 (Year 25)	-1,652		-18,378	55,931		1,464		20,352	37,438		1,392		24,266	35,721		-1,826		-19,054	57,587	
WY 2060 (Year 50)	444		-17,615	-55,312		2,017		21,963	40,455		2,174		25,782	36,993		358		-18,072	-56,357	
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-4,180		-10,877					3,820	1,837		-3,468			10,665		-8,381				
WY 2015 (Year 5)	-7,523		-19,578					11,596	17,533		-3,022			25,849		-8,381				
WY 2025 (Year 15)	-4,447		-19,395					18,203	33,415		350			34,025		4,740				
WY 2035 (Year 25)	-1,652		-18,378					20,352	37,438		1,392			35,721		-1,826				
WY 2060 (Year 50)	444		-17,615					21,963	40,455		2,174			36,993		358				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-4,180			-30,416		-1,753			1,837		-3,468		3,873							
WY 2015 (Year 5)	-7,523			-54,749		-1,363			17,533		3,022		14,033							
WY 2025 (Year 15)	-4,447			-56,758		727			33,415		350		22,245							
WY 2035 (Year 25)	-1,652			-55,931		1,464			37,438		1,392		24,266							
WY 2060 (Year 50)	444			-55,312		2,017			40,455		2,174		25,782							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-4,180		-10,877	-30,416		-1,753		3,820	1,837		-3,468		3,873	10,665		-8,381		-22,001		
WY 2015 (Year 5)	-7,523		-19,578	-54,749		-1,363		11,596	17,533		-3,022		14,033	25,849		-8,381		-22,001		
WY 2025 (Year 15)	-4,447		-19,395	-56,758		727		18,203	33,415		350		22,245	34,025		-4,740		-20,364		
WY 2035 (Year 25)	-1,652		-18,378	-55,931		1,464		20,352	37,438		1,392		24,266	35,721		-1,826		-19,054		
WY 2060 (Year 50)	444		-17,615	-55,312		2,017		21,963	40,455		2,174		25,782	36,993		358		-18,072		
Central Valley steelhead																				
WY 2010 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2011 (Year 1)	-6,184		-14,833		-6,184	-3,763		4,936	4,800	-5,525	-5,525		4,507	7,710	-5,525	-12,396		-29,971		-12,396
WY 2015 (Year 5)	-11,131		-26,700		-11,131	-3,170		14,738	16,517	-4,851	-4,851		16,241	18,956	-4,851	-12,396		-29,971		-12,396
WY 2025 (Year 15)	-6,835		-25,749		-6,835	898		22,853	76,222	168	168		25,740	25,282	168	-7,265		-27,036		-7,265
WY 2035 (Year 25)	-2,904		-23,801		-2,904	2,292		25,438	28,875	1,569	1,569		28,101	26,679	1,569	-3,161		-24,688		-3,161
WY 2060 (Year 50)	44		-22,341		44	3,337		27,377	30,865	2,619	2,619		29,871	27,727	2,619	-82		-22,927		-82
Delta Smelt																				
WY 2010 (Year 0)							0	0				0	0				0	0		
WY 2011 (Year 1)							19,612	19,612				19,153	19,153				-54,858	-54,858		
WY 2015 (Year 5)							36,582	36,582				34,492	34,492				-54,858	-54,858		
WY 2025 (Year 15)							40,478	40,478				37,063	37,063				-54,858	-54,858		
WY 2035 (Year 25)							41,257	41,257				37,577	37,577				-54,858	-54,858		
WY 2060 (Year 50)							41,842	41,842				37,963	37,963				-54,858	-54,858		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 74
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 35.4L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	11,361		1,971	14,322		11,727		8,629	31,657		11,952		9,362	38,289		22,827		3,983	28,901	
WY 2014 (Year 5)	20,450		3,547	25,780		22,250		18,165	68,189		24,336		23,590	80,940		22,827		3,983	28,901	
WY 2024 (Year 15)	27,240		7,461	35,024		26,479		25,706	88,785		31,033		35,477	99,871		28,127		7,651	36,268	
WY 2034 (Year 25)	31,763		10,435	41,273		28,240		29,469	96,006		33,742		40,194	104,742		32,367		10,586	42,163	
WY 2059 (Year 50)	35,155		12,666	45,959		29,560		32,291	101,422		35,773		43,732	108,394		35,547		12,787	46,583	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	11,361		1,971					8,629	31,657		11,952			38,289		22,827				
WY 2014 (Year 5)	20,450		3,547					18,165	68,189		24,336			80,940		22,827				
WY 2024 (Year 15)	27,240		7,461					25,706	88,785		31,033			99,871		28,127				
WY 2034 (Year 25)	31,763		10,435					29,469	96,006		33,742			104,742		32,367				
WY 2059 (Year 50)	35,155		12,666					32,291	101,422		35,773			108,394		35,547				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	11,361			14,322		11,727			31,657		11,952		9,362							
WY 2014 (Year 5)	20,450			25,780		22,250			68,189		24,336		23,590							
WY 2024 (Year 15)	27,240			35,024		26,479			88,785		31,033		35,477							
WY 2034 (Year 25)	31,763			41,273		28,240			96,006		33,742		40,194							
WY 2059 (Year 50)	35,155			45,959		29,560			101,422		35,773		43,732							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	11,361		1,971	14,322		11,727		8,629	31,657		11,952		9,362	38,289		22,827		3,983		
WY 2014 (Year 5)	20,450		3,547	25,780		22,250		18,165	68,189		24,336		23,590	80,940		22,827		3,983		
WY 2024 (Year 15)	27,240		7,461	35,024		26,479		25,706	88,785		31,033		35,477	99,871		28,127		7,651		
WY 2034 (Year 25)	31,763		10,435	41,273		28,240		29,469	96,006		33,742		40,194	104,742		32,367		10,586		
WY 2059 (Year 50)	35,155		12,666	45,959		29,560		32,291	101,422		35,773		43,732	108,394		35,547		12,787		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	22,744		4,315		22,744	23,510		14,161	28,712	24,022	24,022		15,169	31,980	24,022	45,700		8,714		45,700
WY 2014 (Year 5)	40,940		7,767		40,940	44,779		28,986	57,808	48,847	48,847		35,602	65,861	48,847	45,700		8,714		45,700
WY 2024 (Year 15)	52,708		14,216		52,708	53,307		38,894	71,807	60,804	60,804		50,441	80,634	60,804	54,477		14,615		54,477
WY 2034 (Year 25)	60,304		19,030		60,304	56,772		43,590	77,032	65,085	65,085		56,121	84,916	65,085	61,498		19,336		61,498
WY 2059 (Year 50)	66,000		22,641		66,000	59,371		47,111	80,952	68,295	68,295		60,380	88,127	68,295	66,764		22,877		66,764
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							40,377	40,377				41,436	41,436				11,522	11,522		
WY 2014 (Year 5)							73,848	73,848				74,599	74,599				11,522	11,522		
WY 2024 (Year 15)							80,400	80,400				80,139	80,139				11,522	11,522		
WY 2034 (Year 25)							81,711	81,711				81,247	81,247				11,522	11,522		
WY 2059 (Year 50)							82,694	82,694				82,078	82,078				11,522	11,522		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 75
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 87.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	7,434		-329			8,035		6,276	16,903		8,021		6,784	20,834		14,757		-815		
WY 2014 (Year 5)	13,382		-591			15,842		14,835	41,319		17,398		19,691	47,164		14,757		-815		
WY 2024 (Year 15)	18,249		1,299			18,967		21,030	56,477		22,274		29,226	59,863		18,632		1,117		
WY 2034 (Year 25)	21,548		2,837			19,997		23,360	60,715		23,756		31,825	62,558		21,732		2,663		
WY 2059 (Year 50)	24,023		3,991			20,769		25,108	63,894		24,868		33,773	64,580		24,057		3,823		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	7,434		-329					6,276	16,903		8,021			20,834		14,757				
WY 2014 (Year 5)	13,382		-591					14,835	41,319		17,398			47,164		14,757				
WY 2024 (Year 15)	18,249		1,299					21,030	56,477		22,274			59,863		18,632				
WY 2034 (Year 25)	21,548		2,837					23,360	60,715		23,756			62,558		21,732				
WY 2059 (Year 50)	24,023		3,991					25,108	63,894		24,868			64,580		24,057				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	7,434			-3,647		8,035			16,903		8,021		6,784							
WY 2014 (Year 5)	13,382			-6,556		15,842			41,319		17,398		19,691							
WY 2024 (Year 15)	18,249			-2,403		18,967			56,477		22,274		29,226							
WY 2034 (Year 25)	21,548			1,211		19,997			60,715		23,756		31,825							
WY 2059 (Year 50)	24,023			3,922		20,769			63,894		24,868		33,773							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	7,434		-329	-3,642		8,035		6,276	16,903		8,021		6,784	20,834		14,757		-815	-6,067	
WY 2014 (Year 5)	13,382		-591	-6,556		15,842		14,835	41,319		17,398		19,691	47,164		14,757		-815	-8,067	
WY 2024 (Year 15)	18,249		1,299	-2,403		18,967		21,030	56,477		22,274		29,226	59,863		18,632		1,117	-3,469	
WY 2034 (Year 25)	21,548		2,837	1,211		19,997		23,360	60,715		23,756		31,825	62,558		21,732		2,663	210	
WY 2059 (Year 50)	24,023		3,991	3,922		20,769		25,108	63,894		24,868		33,773	64,580		24,057		3,823	2,969	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	15,148		-114	-2,992	15,148	16,391		9,593	15,717	16,437			10,084	16,936	16,437	30,102		-497	-6,653	30,102
WY 2014 (Year 5)	27,266		-205	-5,385	27,266	32,399		21,762	34,532	35,001			26,966	37,553	35,001	30,102		-497	-6,653	30,102
WY 2024 (Year 15)	35,692		3,373	-886	35,692	38,735		29,653	44,507	43,611			38,473	47,337	43,611	36,490		3,090	-1,788	36,490
WY 2034 (Year 25)	41,221		6,744	2,953	41,221	40,754		32,503	47,477	45,936			41,583	49,558	45,936	41,601		5,960	2,104	41,601
WY 2059 (Year 50)	45,367		8,398	5,832	45,367	42,269		34,640	49,708	47,679			43,916	51,228	47,679	45,434		8,113	5,022	45,434

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 86
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 93.7L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	6,642		263			7,064		5,091	16,120		7,222		5,736	20,509		13,440		686		
WY 2014 (Year 5)	11,955		473			13,765		11,788	37,285		15,296		15,999	44,573		13,440		686		
WY 2024 (Year 15)	15,833		2,001			16,293		16,507	49,314		19,236		23,365	55,184		16,468		2,197		
WY 2034 (Year 25)	18,404		3,203			17,120		18,300	52,685		20,433		25,393	57,439		18,890		3,406		
WY 2059 (Year 50)	20,332		4,105			17,740		19,645	55,214		21,330		26,915	59,129		20,707		4,313		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	6,642		263					5,091	16,120		7,222			20,509		13,440				
WY 2014 (Year 5)	11,955		473					11,788	37,285		15,296			44,573		13,440				
WY 2024 (Year 15)	15,833		2,001					16,507	49,314		19,236			55,184		16,468				
WY 2034 (Year 25)	18,404		3,203					18,300	52,685		20,433			57,439		18,890				
WY 2059 (Year 50)	20,332		4,105					19,645	55,214		21,330			59,129		20,707				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	6,642			2,346		7,064			16,120		7,222		5,736							
WY 2014 (Year 5)	11,955			4,222		13,765			37,285		15,296		15,999							
WY 2024 (Year 15)	15,833			8,168		16,293			49,314		19,236		23,365							
WY 2034 (Year 25)	18,404			11,137		17,120			52,685		20,433		25,393							
WY 2059 (Year 50)	20,332			13,364		17,740			55,214		21,330		26,915							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	6,642		263	2,346		7,064		5,091	16,120		7,222		5,736	20,509		13,440		686	5,515	
WY 2014 (Year 5)	11,955		473	4,222		13,765		11,788	37,285		15,296		15,999	44,573		13,440		686	5,515	
WY 2024 (Year 15)	15,833		2,001	8,168		16,293		16,507	49,314		19,236		23,365	55,184		16,468		2,197	9,191	
WY 2034 (Year 25)	18,404		3,203	11,137		17,120		18,300	52,685		20,433		25,393	57,439		18,890		3,406	12,132	
WY 2059 (Year 50)	20,332		4,105	13,364		17,740		19,645	55,214		21,330		26,915	59,129		20,707		4,313	14,337	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	13,215		891	2,188	13,215	14,086		7,969	14,540	14,454			8,845	16,801	14,454	26,744		2,098	5,252	26,744
WY 2014 (Year 5)	23,788		1,604	3,938	23,788	27,565		17,699	30,918	30,256			22,663	35,826	30,256	26,744		2,098	5,252	26,744
WY 2024 (Year 15)	30,516		4,502	8,052	30,516	32,651		23,775	38,906	37,238			31,669	44,027	37,238	31,769		4,911	9,120	31,769
WY 2034 (Year 25)	34,841		6,750	11,168	34,841	34,268		25,984	41,285	39,124			34,121	45,892	39,124	35,789		7,160	12,214	35,789
WY 2059 (Year 50)	38,085		8,435	13,505	38,085	35,481		27,641	43,070	40,538			35,961	47,292	40,538	38,804		8,848	14,534	38,804

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 75
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 41.9R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-5,745		-24,069	-58,339		-2,701		3,741	-3,994		-5,059		1,427	3,924		-12,177		-43,265	-108,731	
WY 2015 (Year 5)	-10,340		-43,325	-105,011		-2,292		13,359	12,996		-4,212		13,705	18,548		-12,177		-43,265	-108,731	
WY 2025 (Year 15)	-4,928		-43,570	-107,669		819		22,804	35,090		1,077		26,201	30,763		-6,117		-40,385	-103,968	
WY 2035 (Year 25)	-139		-41,840	-105,129		1,981		26,086	40,974		2,777		29,402	33,331		-1,269		-38,080	-100,157	
WY 2060 (Year 50)	3,453		-40,543	-103,224		2,852		28,547	45,387		4,052		31,803	35,256		2,367		-36,352	-97,300	
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-5,745		-24,069					3,741	-3,994		-5,059			3,924		-12,177				
WY 2015 (Year 5)	-10,340		-43,325					13,359	12,996		-4,212			18,548		-12,177				
WY 2025 (Year 15)	-4,928		-43,570					22,804	35,090		1,077			30,763		-6,117				
WY 2035 (Year 25)	-139		-41,840					26,086	40,974		2,777			33,331		-1,269				
WY 2060 (Year 50)	3,453		-40,543					28,547	45,387		4,052			35,256		2,367				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-5,745			-58,339		-2,701			-3,994		-5,059		1,427							
WY 2015 (Year 5)	-10,340			-105,011		-2,292			12,996		-4,212		13,705							
WY 2025 (Year 15)	-4,928			-107,669		819			35,090		1,077		26,201							
WY 2035 (Year 25)	-139			-105,129		1,981			40,974		2,777		29,402							
WY 2060 (Year 50)	3,453			-103,224		2,852			45,387		4,052		31,803							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-5,745		-24,069	-58,339		-2,701		3,741	-3,994		-5,059		1,427	3,924		-12,177		-43,265		
WY 2015 (Year 5)	-10,340		-43,325	-105,011		-2,292		13,359	12,996		-4,212		13,705	18,548		-12,177		-43,265		
WY 2025 (Year 15)	-4,928		-43,570	-107,669		819		22,804	35,090		1,077		26,201	30,763		-6,117		-40,385		
WY 2035 (Year 25)	-139		-41,840	-105,129		1,981		26,086	40,974		2,777		29,402	33,331		-1,269		-38,080		
WY 2060 (Year 50)	3,453		-40,543	-103,224		2,852		28,547	45,387		4,052		31,803	35,256		2,367		-36,352		
Central Valley steelhead																				
WY 2010 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2011 (Year 1)	-10,064		-31,675		-10,064	-5,334		4,553	4,399	-8,673	-8,673		1,275	5,835	-8,673	-20,801		-57,914		-20,801
WY 2015 (Year 5)	-18,116		-57,016		-18,116	-4,373		16,476	19,283	-7,532	-7,532		15,187	19,280	-7,532	-20,801		-57,914		-20,801
WY 2025 (Year 15)	-10,101		-55,869		-10,101	1,790		28,069	33,287	576	576		29,658	29,261	576	-11,720		-52,707		-11,720
WY 2035 (Year 25)	-2,884		-52,418		-2,884	4,009		32,011	37,318	2,908	2,908		33,398	31,514	2,908	-4,454		-48,540		-4,454
WY 2060 (Year 50)	2,529		-49,830		2,529	5,673		34,967	40,342	4,657	4,657		36,203	33,203	4,657	995		-45,416		995
Delta Smelt																				
WY 2010 (Year 0)							0	0				0	0				0	0		
WY 2011 (Year 1)							22,912	22,912				22,646	22,646				-97,182	-97,182		
WY 2015 (Year 5)							43,025	43,025				40,787	40,787				-97,182	-97,182		
WY 2025 (Year 15)							47,864	47,864				43,830	43,830				-97,182	-97,182		
WY 2035 (Year 25)							48,832	48,832				44,438	44,438				-97,182	-97,182		
WY 2060 (Year 50)							49,557	49,557				44,895	44,895				-97,182	-97,182		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 76
SAM results showing wetted-area weighted relative response (square feet) at Lower American River RM 10.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	811		-14	2,489		1,780		2,124	4,938		1,136		3,370	10,289		1,579		914	7,476	
WY 2014 (Year 5)	1,459		-26	4,480		3,981		5,922	14,625		3,389		8,904	20,977		1,579		914	7,476	
WY 2024 (Year 15)	3,098		939	5,917		5,144		8,699	21,395		5,030		12,326	24,822		3,023		1,793	8,367	
WY 2034 (Year 25)	4,345		1,712	6,867		5,466		9,492	22,974		5,444		13,091	25,602		4,178		2,496	9,079	
WY 2059 (Year 50)	5,280		2,291	7,580		5,708		10,086	24,158		5,755		13,665	26,187		5,044		3,024	9,614	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	811		-14					2,124	4,938		1,136			10,289		1,579				
WY 2014 (Year 5)	1,459		-26					5,922	14,625		3,389			20,977		1,579				
WY 2024 (Year 15)	3,098		939					8,699	21,395		5,030			24,822		3,023				
WY 2034 (Year 25)	4,345		1,712					9,492	22,974		5,444			25,602		4,178				
WY 2059 (Year 50)	5,280		2,291					10,086	24,158		5,755			26,187		5,044				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	811			2,489		1,780			4,938		1,136		3,370							
WY 2014 (Year 5)	1,459			4,480		3,981			14,625		3,389		8,904							
WY 2024 (Year 15)	3,098			5,917		5,144			21,395		5,030		12,326							
WY 2034 (Year 25)	4,345			6,867		5,466			22,974		5,444		13,091							
WY 2059 (Year 50)	5,280			7,580		5,708			24,158		5,755		13,665							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	811		-14	2,489		1,780		2,124	4,938		1,136		3,370	10,289		1,579		914		
WY 2014 (Year 5)	1,459		-26	4,480		3,981		5,922	14,625		3,389		8,904	20,977		1,579		914		
WY 2024 (Year 15)	3,098		939	5,917		5,144		8,699	21,395		5,030		12,326	24,822		3,023		1,793		
WY 2034 (Year 25)	4,345		1,712	6,867		5,466		9,492	22,974		5,444		13,091	25,602		4,178		2,496		
WY 2059 (Year 50)	5,280		2,291	7,580		5,708		10,086	24,158		5,755		13,665	26,187		5,044		3,024		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	3,059		116		3,059	4,068		2,968	4,065	3,612	3,612		4,262	6,754	3,612	6,509		1,647		6,509
WY 2014 (Year 5)	5,506		208		5,506	8,871		7,910	10,655	8,549	8,549		10,955	14,096	8,549	6,509		1,647		6,509
WY 2024 (Year 15)	8,112		1,726		8,112	11,228		11,327	14,829	11,226	11,226		14,938	16,979	11,226	8,525		3,011		8,525
WY 2034 (Year 25)	9,952		2,930		9,952	11,860		12,284	15,860	11,851	11,851		15,833	17,582	11,851	10,138		4,102		10,138
WY 2059 (Year 50)	11,332		3,834		11,332	12,334		13,001	16,633	12,319	12,319		16,505	18,034	12,319	11,348		4,920		11,348
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							8,712	8,712				10,691	10,691				8,388	8,388		
WY 2014 (Year 5)							16,196	16,196				19,251	19,251				8,388	8,388		
WY 2024 (Year 15)							17,871	17,871				20,684	20,684				8,388	8,388		
WY 2034 (Year 25)							18,206	18,206				20,970	20,970				8,388	8,388		
WY 2059 (Year 50)							18,457	18,457				21,185	21,185				8,388	8,388		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 77

SAM results showing wetted-area weighted relative response (square feet) at Lower American River RM 10.6L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-634		-1,864	-2,577		-173		260	-764		-627		835	2,164		-1,450		-3,017	-3,723	
WY 2014 (Year 5)	-1,141		-3,356	-4,638		-19		1,351	1,259		-567		2,884	5,113		-1,450		-3,017	-3,723	
WY 2024 (Year 15)	-465		-3,119	-4,403		413		2,749	4,263		85		4,595	6,658		-741		-2,593	-3,318	
WY 2034 (Year 25)	127		-2,780	-4,009		595		3,318	5,147		321		5,069	6,989		-173		-2,253	-2,993	
WY 2059 (Year 50)	571		-2,525	-3,713		733		3,744	5,810		497		5,425	7,238		253		-1,998	-2,750	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-634		-1,864					260	-764		-627			2,164		-1,450				
WY 2014 (Year 5)	-1,141		-3,356					1,351	1,259		-567			5,113		-1,450				
WY 2024 (Year 15)	-465		-3,119					2,749	4,263		85			6,658		-741				
WY 2034 (Year 25)	127		-2,780					3,318	5,147		321			6,989		-173				
WY 2059 (Year 50)	571		-2,525					3,744	5,810		497			7,238		253				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-634			-2,577		-173			-764		-627		835							
WY 2014 (Year 5)	-1,141			-4,638		-19			1,259		-567		2,884							
WY 2024 (Year 15)	-465			-4,403		413			4,263		85		4,595							
WY 2034 (Year 25)	127			-4,009		595			5,147		321		5,069							
WY 2059 (Year 50)	571			-3,713		733			5,810		497		5,425							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-634		-1,864	-2,577		-173		260	-764		-627		835	2,164		-1,450		-3,017		
WY 2014 (Year 5)	-1,141		-3,356	-4,638		-19		1,351	1,259		-567		2,884	5,113		-1,450		-3,017		
WY 2024 (Year 15)	-465		-3,119	-4,403		413		2,749	4,263		85		4,595	6,658		-741		-2,593		
WY 2034 (Year 25)	127		-2,780	-4,009		595		3,318	5,147		321		5,069	6,989		-173		-2,253		
WY 2059 (Year 50)	571		-2,525	-3,713		733		3,744	5,810		497		5,425	7,238		253		-1,998		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	-911		-2,489		-911	-357		345	73	-809	-809		946	1,586	-809	-1,756		-4,110		-1,756
WY 2014 (Year 5)	-1,640		-4,480		-1,640	-44		1,695	1,573	-566	-566		3,250	3,775	-566	-1,756		-4,110		-1,756
WY 2024 (Year 15)	-659		-4,056		-659	803		3,361	3,416	412	412		5,181	4,982	412	-778		-3,452		-778
WY 2034 (Year 25)	199		-3,518		199	1,150		4,022	4,020	725	725		5,722	5,268	725	5		-2,925		5
WY 2059 (Year 50)	843		-3,114		843	1,411		4,518	4,472	960	960		6,128	5,483	960	593		-2,531		593
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							2,288	2,288				3,697	3,697				-7,978	-7,978		
WY 2014 (Year 5)							4,380	4,380				6,657	6,657				-7,978	-7,978		
WY 2024 (Year 15)							4,947	4,947				7,154	7,154				-7,978	-7,978		
WY 2034 (Year 25)							5,060	5,060				7,253	7,253				-7,978	-7,978		
WY 2059 (Year 50)							5,145	5,145				7,328	7,328				-7,978	-7,978		

Notes:

1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River

2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 78
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 71.3R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-819		-2,383	-4,489		28		1,879	2,200		-537		2,323	5,802		-1,662		-4,653	-8,737	
WY 2015 (Year 5)	-1,475		-4,289	-8,080		701		5,104	9,100		230		6,864	13,015		-1,662		-4,653	-8,737	
WY 2025 (Year 15)	-199		-3,978	-7,818		1,550		7,582	15,046		1,596		10,111	16,403		-280		-4,029	-7,893	
WY 2035 (Year 25)	888		-3,539	-7,248		1,837		8,380	16,543		2,013		10,914	17,105		825		-3,529	-7,218	
WY 2060 (Year 50)	1,702		-3,210	-6,822		2,051		8,980	17,665		2,326		11,515	17,632		1,655		-3,154	-6,712	
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-819		-2,383					1,879	2,200		-537			5,802		-1,662				
WY 2015 (Year 5)	-1,475		-4,289					5,104	9,100		230			13,015		-1,662				
WY 2025 (Year 15)	-199		-3,978					7,582	15,046		1,596			16,403		-280				
WY 2035 (Year 25)	888		-3,539					8,380	16,543		2,013			17,105		825				
WY 2060 (Year 50)	1,702		-3,210					8,980	17,665		2,326			17,632		1,655				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-819			-4,489		28			2,200		-537		2,323							
WY 2015 (Year 5)	-1,475			-8,080		701			9,100		230		6,864							
WY 2025 (Year 15)	-199			-7,818		1,550			15,046		1,596		10,111							
WY 2035 (Year 25)	888			-7,248		1,837			16,543		2,013		10,914							
WY 2060 (Year 50)	1,702			-6,822		2,051			17,665		2,326		11,515							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-819		-2,383	-4,489		28		1,879	2,200		-537		2,323	5,802		-1,662		-4,653		
WY 2015 (Year 5)	-1,475		-4,289	-8,080		701		5,104	9,100		230		6,864	13,015		-1,662		-4,653		
WY 2025 (Year 15)	-199		-3,978	-7,818		1,550		7,582	15,046		1,596		10,111	16,403		-280		-4,029		
WY 2035 (Year 25)	888		-3,539	-7,248		1,837		8,380	16,543		2,013		10,914	17,105		825		-3,529		
WY 2060 (Year 50)	1,702		-3,210	-6,822		2,051		8,980	17,665		2,326		11,515	17,632		1,655		-3,154		
Central Valley steelhead																				
WY 2010 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2011 (Year 1)	-869		-3,286		-869	49		2,539	2,625	-538	-538		2,898	4,034	-538	-1,729		-6,419		-1,729
WY 2015 (Year 5)	-1,565		-5,914		-1,565	1,398		6,702	7,596	951	951		8,300	9,236	951	-1,729		-6,419		-1,729
WY 2025 (Year 15)	307		-5,223		307	3,066		9,757	11,251	3,060	3,060		12,078	11,840	3,060	247		-5,297		247
WY 2035 (Year 25)	1,874		-4,407		1,874	3,611		10,719	12,243	3,639	3,639		13,018	12,414	3,639	1,829		4,399		1,829
WY 2060 (Year 50)	3,049		-3,795		3,049	4,020		11,441	12,988	4,072	4,072		13,723	12,845	4,072	3,015		-3,726		3,015
Delta Smelt																				
WY 2010 (Year 0)							0	0				0	0				0	0		
WY 2011 (Year 1)							7,647	7,647				8,141	8,141				-12,544	-12,544		
WY 2015 (Year 5)							14,234	14,234				14,660	14,660				-12,544	-12,544		
WY 2025 (Year 15)							15,721	15,721				15,752	15,752				-12,544	-12,544		
WY 2035 (Year 25)							16,019	16,019				15,970	15,970				-12,544	-12,544		
WY 2060 (Year 50)							16,242	16,242				16,134	16,134				-12,544	-12,544		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 79
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 73.5L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-1,486		-4,895	-10,230		-356		2,546	2,396		1,179		1,376	4,579		-3,110		-10,487	-21,271	
WY 2014 (Year 5)	-2,675		-8,811	-18,413		354		7,238	12,233		-238		6,972	12,753		-3,110		-10,487	-21,271	
WY 2024 (Year 15)	-589		-8,373	-17,940		1,657		11,181	21,465		1,926		12,157	17,984		-820		-9,399	-19,475	
WY 2034 (Year 25)	1,199		-7,632	-16,743		2,131		12,539	23,895		2,621		13,498	19,084		1,011		-8,529	-18,038	
WY 2059 (Year 50)	2,540		-7,075	-15,845		2,487		13,557	25,718		3,142		14,503	19,909		2,385		-7,876	-16,960	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-1,486		-4,895					2,546	2,396		-1,179			4,579		-3,110				
WY 2014 (Year 5)	-2,675		-8,811					7,238	12,233		-238			12,753		-3,110				
WY 2024 (Year 15)	-589		-8,373					11,181	21,465		1,926			17,984		-820				
WY 2034 (Year 25)	1,199		-7,632					12,539	23,895		2,621			19,084		1,011				
WY 2059 (Year 50)	2,540		-7,075					13,557	25,718		3,142			19,909		2,385				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-1,486			-10,230		-356			2,396		-1,179		1,376							
WY 2014 (Year 5)	-2,675			-18,413		354			12,233		-238		6,972							
WY 2024 (Year 15)	-589			-17,940		1,657			21,465		1,926		12,157							
WY 2034 (Year 25)	1,199			-16,743		2,131			23,895		2,621		13,498							
WY 2059 (Year 50)	2,540			-15,845		2,487			25,718		3,142		14,503							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-1,486		-4,895	-10,230		-356		2,546	2,396		-1,179		1,376	4,579		-3,110		-10,487		
WY 2014 (Year 5)	-2,675		-8,811	-18,413		354		7,238	12,233		-238		6,972	12,753		-3,110		-10,487		
WY 2024 (Year 15)	-589		-8,373	-17,940		1,657		11,181	21,465		1,926		12,157	17,984		-820		-9,399		
WY 2034 (Year 25)	1,199		-7,632	-16,743		2,131		12,539	23,895		2,621		13,498	19,084		1,011		-8,529		
WY 2059 (Year 50)	2,540		-7,075	-15,845		2,487		13,557	25,718		3,142		14,503	19,909		2,385		-7,876		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	-2,527		-6,748		-2,527	-873		3,394	3,394	-1,982	-1,982		1,722	3,026	-1,982	-5,197		-14,349		-5,197
WY 2014 (Year 5)	-4,549		-12,147		-4,549	448		9,403	10,552	-442	-442		8,262	8,893	-442	5,197		-14,349		-5,197
WY 2024 (Year 15)	-1,446		-11,074		-1,446	3,001		14,248	16,268	2,906	2,906		14,259	12,927	2,906	-1,767		-12,382		-1,767
WY 2034 (Year 25)	1,238		-9,676		1,238	3,903		15,876	17,901	3,868	3,868		15,821	13,842	3,868	977		-10,808		977
WY 2059 (Year 50)	3,250		-8,677		3,250	4,578		17,097	19,125	4,590	4,590		16,992	14,528	4,590	3,036		-9,628		3,036
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							10,807	10,807				8,840	8,840				-25,628	-25,628		
WY 2014 (Year 5)							20,164	20,164				15,922	15,922				-25,628	-25,628		
WY 2024 (Year 15)							22,316	22,316				17,110	17,110				-25,628	-25,628		
WY 2034 (Year 25)							22,747	22,747				17,347	17,347				-25.628	-25,628		
WY 2059 (Year 50)							23,070	23,070				17,526	17,526				-25,628	-25,628		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 80
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 78.8L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-353		-662	-1,561		-127		597	1,742		-287		661	2,588		-741		-1,359	-3,102	
WY 2014 (Year 5)	-636		-1,191	-2,811		-53		1,536	4,563		-177		1,990	5,493		-741		-1,359	-3,102	
WY 2024 (Year 15)	-252		-1,074	-2,675		177		2,263	6,419		212		2,981	6,693		-316		-1,158	-2,779	
WY 2034 (Year 25)	84		-927	-2,441		266		2,521	6,909		343		3,241	6,944		23		-998	-2,520	
WY 2059 (Year 50)	336		-817	-2,266		333		2,715	7,276		441		3,436	7,133		278		-877	-2,326	
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-353		-662					597	1,742		-287			2,588		-741				
WY 2014 (Year 5)	-636		-1,191					1,536	4,563		-177			5,493		-741				
WY 2024 (Year 15)	-252		-1,074					2,263	6,419		212			6,693		-316				
WY 2034 (Year 25)	84		-927					2,521	6,909		343			6,944		23				
WY 2059 (Year 50)	336		-817					2,715	7,276		441			7,133		278				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-353			-1,561		-127			1,742		-287		661							
WY 2014 (Year 5)	-636			-2,811		-53			4,563		-177		1,990							
WY 2024 (Year 15)	-252			-2,675		177			6,419		212		2,981							
WY 2034 (Year 25)	84			-2,441		266			6,909		343		3,241							
WY 2059 (Year 50)	336			-2,266		333			7,276		441		3,436							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-353		-662	-1,561		-127		597	1,742		-287		661	2,588		-741		-1,359		
WY 2014 (Year 5)	-636		-1,191	-2,811		-53		1,536	4,563		-177		1,990	5,493		-741		-1,359		
WY 2024 (Year 15)	-252		-1,074	-2,675		177		2,263	6,419		212		2,981	6,693		-316		-1,158		
WY 2034 (Year 25)	84		-927	-2,441		266		2,521	6,909		343		3,241	6,944		23		-998		
WY 2059 (Year 50)	336		-817	-2,266		333		2,715	7,276		441		3,436	7,133		278		-877		
Central Valley steelhead																				
WY 2009 (Year 0)	0		0		0	0		0	0	0	0		0	0	0	0		0		0
WY 2010 (Year 1)	-617		-955		-617	-281		813	1,478	-505	-505		832	1,752	-505	-1,262		-1,952		-1,262
WY 2014 (Year 5)	-1,111		-1,719		-1,111	147		2,038	3,457	-340	-340		2,422	3,787	-340	-1,262		-1,952		-1,262
WY 2024 (Year 15)	-545		-1,474		-545	306		2,940	4,615	259	259		3,579	4,691	259	-629		-1,589		-629
WY 2034 (Year 25)	-42		-1,202		-42	475		3,251	4,945	439	439		3,884	4,894	439	-123		-1,299		-123
WY 2059 (Year 50)	334		-998		334	601		3,484	5,193	573	573		4,113	5,047	573	257		-1,082		257
Delta Smelt																				
WY 2009 (Year 0)							0	0				0	0				0	0		
WY 2010 (Year 1)							2,867	2,867				2,995	2,995				-3,203	-3,203		
WY 2014 (Year 5)							5,289	5,289				5,392	5,392				-3,203	-3,203		
WY 2024 (Year 15)							5,800	5,800				5,793	5,793				-3,203	-3,203		
WY 2034 (Year 25)							5,902	5,902				5,874	5,874				-3,203	-3,203		
WY 2059 (Year 50)							5,978	5,978				5,934	5,934				-3,203	-3,203		

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 83
SAM results showing wetted-area weighted relative response (square feet) at Feather River RM 5.5L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-275		-831			26		2,694	3,033		-885		2,808	7,055		-554		-1,099		
WY 2014 (Year 5)	-495		-1,496			983		7,214	13,075		260		9,318	17,344		-554		-1,099		
WY 2024 (Year 15)	2,379		1,060			2,363		11,059	22,331		2,534		14,586	23,057		2,379		1,588		
WY 2034 (Year 25)	4,700		3,171			2,904		12,502	24,925		3,313		16,018	24,276		4,725		3,738		
WY 2059 (Year 50)	6,440		4,754			3,309		13,584	26,870		3,897		17,091	25,190		6,485		5,351		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	-275		-831					2,694	3,033		-885			7,055		-554				
WY 2014 (Year 5)	-495		-1,496					7,214	13,075		260			17,344		-554				
WY 2024 (Year 15)	2,379		1,060					11,059	22,331		2,534			23,057		2,379				
WY 2034 (Year 25)	4,700		3,171					12,502	24,925		3,313			24,276		4,725				
WY 2059 (Year 50)	6,440		4,754					13,584	26,870		3,897			25,190		6,485				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-275			-1,668		26			3,033		-885		2,808							
WY 2014 (Year 5)	-495			-3,002		983			13,075		260		9,318							
WY 2024 (Year 15)	2,379			695		2,363			22,331		2,534		14,586							
WY 2034 (Year 25)	4,700			3,787		2,904			24,925		3,313		16,018							
WY 2059 (Year 50)	6,440			6,106		3,309			26,870		3,897		17,091							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-275		-831	-1,668		26		2,694	3,033		-885		2,808	7,055		-554		-1,099	-1,959	
WY 2014 (Year 5)	-495		-1,496	-3,002		983		7,214	13,075		260		9,318	17,344		-554		-1,099	-1,959	
WY 2024 (Year 15)	2,379		1,060	695		2,363		11,059	22,331		2,534		14,586	23,057		2,379		1,585	1,993	
WY 2034 (Year 25)	4,700		3,171	3,787		2,904		12,502	24,925		3,313		16,018	24,276		4,725		3,738	5,153	
WY 2059 (Year 50)	6,440		4,754	6,106		3,309		13,584	26,870		3,897		17,091	25,190		6,485		5,351	7,524	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	-704		-1,272	-2,228	-704	-108		3,636	3,553	-1,433			3,502	4,752	-1,433	-1,419		-1,729	-3,197	-1,419
WY 2014 (Year 5)	1,267		-2,290	-4,010	-1,267	1,727		9,524	10,639	552			11,257	12,057	552	-1,419		-1,729	-3,197	-1,419
WY 2024 (Year 15)	3,309		1,422	-415	3,309	4,447		14,304	16,379	4,111			17,430	16,436	4,111	3,288		2,183	726	3,288
WY 2034 (Year 25)	7,026		4,494	2,639	7,026	5,479		16,050	18,141	5,193			19,117	17,458	5,193	7,053		5,313	3,864	7,053
WY 2059 (Year 50)	9,814		6,797	4,930	9,814	6,253		17,358	19,462	6,005			20,382	18,225	6,005	9,877		7,660	6,217	9,877

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 84
SAM results showing wetted-area weighted relative response (square feet) at Feather River RM 7.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	4,614		-465			5,322		4,347	12,257		5,131		5,282	15,572		9,041		-990		
WY 2014 (Year 5)	8,306		-837			10,752		10,951	29,503		11,326		14,117	32,573		9,041		-990		
WY 2024 (Year 15)	11,191		-35			12,675		14,769	38,679		14,139		19,463	39,196		11,280		-141		
WY 2034 (Year 25)	13,130		643			13,084		15,600	40,574		14,725		20,552	40,522		13,071		538		
WY 2059 (Year 50)	14,584		1,152			13,392		16,223	41,995		15,165		21,368	41,518		14,414		1,048		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	4,614		-465					4,347	12,257		5,131			15,572		9,041				
WY 2014 (Year 5)	8,306		-837					10,951	29,503		11,326			32,573		9,041				
WY 2024 (Year 15)	11,191		-35					14,769	38,679		14,139			39,196		11,280				
WY 2034 (Year 25)	13,130		643					15,600	40,574		14,725			40,522		13,071				
WY 2059 (Year 50)	14,584		1,152					16,223	41,995		15,165			41,518		14,414				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	4,614			-1,923		5,322			12,257		5,131		5,282							
WY 2014 (Year 5)	8,306			-3,462		10,752			29,503		11,326		14,117							
WY 2024 (Year 15)	11,191			-1,573		12,675			38,679		14,139		19,463							
WY 2034 (Year 25)	13,130			92		13,084			40,574		14,725		20,552							
WY 2059 (Year 50)	14,584			1,341		13,392			41,995		15,165		21,368							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	4,614		-465	-1,923		5,322		4,347	12,257		5,131		5,282	15,572		9,041		-990	-3,820	
WY 2014 (Year 5)	8,306		-837	-3,462		10,752		10,951	29,503		11,326		14,117	32,573		9,041		-990	-3,820	
WY 2024 (Year 15)	11,191		-35	-1,573		12,675		14,769	38,679		14,139		19,463	39,196		11,280		-141	-1,771	
WY 2034 (Year 25)	13,130		643	92		13,084		15,600	40,574		14,725		20,552	40,522		13,071		538	-132	
WY 2059 (Year 50)	14,584		1,152	1,341		13,392		16,223	41,995		15,165		21,368	41,518		14,414		1,048	1,097	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	9,451		-765	-1,644	9,451	10,733		6,568	11,306	10,550			7,543	12,616	10,550	18,683		-1,628	-3,711	18,683
WY 2014 (Year 5)	17,011		-1,378	-3,319	17,011	21,656		15,642	24,887	22,333			18,919	26,291	22,333	18,683		-1,628	-3,711	18,683
WY 2024 (Year 15)	21,907		123	-1,113	21,907	25,499		20,464	31,019	27,120			25,306	31,566	27,120	22,239		-55	-1,348	22,239
WY 2034 (Year 25)	25,068		1,386	800	25,068	26,312		21,506	32,299	28,100			26,608	32,626	28,100	25,085		1,204	542	25,085
WY 2059 (Year 50)	27,438		2,332	2,234	27,438	26,921		22,287	33,258	28,835			27,584	33,422	28,835	27,219		2,147	1,960	27,219

Notes:

1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River

2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 87
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 114.5R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	-1,600		-2,946			-583		2,949	2,831		-1,373		4,200	8,719		-3,264		-5,953		
WY 2014 (Year 5)	-2,880		-5,303			-233		7,958	12,149		-1,033		11,438	18,754		-3,264		-5,953		
WY 2024 (Year 15)	1,376		-4,936			790		11,901	20,373		550		16,303	23,036		-1,552		-5,202		
WY 2034 (Year 25)	-44		-4,407			1,165		13,229	22,494		1,063		17,532	23,928		-183		-4,602		
WY 2059 (Year 50)	954		-4,010			1,446		14,225	24,084		1,447		18,454	24,597		844		-4,152		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	1,600		-2,946					2,949	2,831		-1,373			8,719		-3,264				
WY 2014 (Year 5)	-2,880		-5,303					7,958	12,149		-1,033			18,754		-3,264				
WY 2024 (Year 15)	-1,376		-4,936					11,901	20,373		550			23,036		-1,552				
WY 2034 (Year 25)	-44		-4,407					13,229	22,494		1,063			23,928		-183				
WY 2059 (Year 50)	954		-4,010					14,225	24,084		1,447			24,597		844				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	-1,600			-5,688		-583			2,831		-1,373		4,200							
WY 2014 (Year 5)	-2,880			-10,238		-233			12,149		-1,033		11,438							
WY 2024 (Year 15)	-1,376			-10,041		790			20,373		550		16,303							
WY 2034 (Year 25)	-44			-9,429		1,165			22,494		1,063		17,532							
WY 2059 (Year 50)	954			-8,970		1,446			24,084		1,447		18,454							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	-1,600		-2,946	-5,688		-583		2,949	2,831		-1,373		4,200	8,719		-3,264		-5,953	-11,396	
WY 2014 (Year 5)	-2,880		-5,303	-10,238		-233		7,958	12,149		-1,033		11,438	18,754		-3,264		-5,953	-11,396	
WY 2024 (Year 15)	-1,376		-4,936	-10,041		790		11,901	20,373		550		16,303	23,036		-1,552		-5,202	-10,480	
WY 2034 (Year 25)	-44		-4,407	-9,429		1,165		13,229	22,494		1,063		17,532	23,928		-183		-4,602	-9,747	
WY 2059 (Year 50)	954		-4,010	-8,970		1,446		14,225	24,084		1,447		18,454	24,597		844		-4,152	-9,197	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	-2,121		-4,103	-5,878	-2,121	-1,226		3,737	3,475	-1,856			4,850	6,025	-1,856	-4,230		-8,270	-11,791	-4,230
WY 2014 (Year 5)	-3,817		-7,385	-10,580	-3,817	-567		9,877	10,096	-1,083			12,991	13,151	-1,083	-4,230		-8,270	-11,791	-4,230
WY 2024 (Year 15)	-1,682		-6,568	-10,069	-1,682	1,429		14,531	15,066	1,282			18,394	16,387	1,282	-1,836		-6,924	-10,532	-1,836
WY 2034 (Year 25)	195		-5,586	-9,190	195	2,134		16,064	16,458	1,969			19,771	17,111	1,969	79		-5,846	-9,524	79
WY 2059 (Year 50)	1,603		-4,850	-8,531	1,603	2,665		17,214	17,502	2,484			20,804	17,654	2,484	1,515		-5,039	-8,768	1,515

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 88
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 130.0L.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	1,610		49			2,215		2,021	5,346		1,932		2,287	6,783		3,299		99		
WY 2015 (Year 5)	2,898		88			4,419		4,787	13,061		4,343		6,278	14,601		3,299		99		
WY 2025 (Year 15)	4,149		601			5,328		6,700	17,730		5,682		9,015	17,950		4,363		617		
WY 2035 (Year 25)	5,022		1,007			5,619		7,378	18,976		6,080		9,725	18,651		5,214		1,032		
WY 2060 (Year 50)	5,676		1,312			5,837		7,887	19,910		6,379		10,258	19,177		5,853		1,343		
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	1,610		49					2,021	5,346		1,932			6,783		3,299				
WY 2015 (Year 5)	2,898		88					4,787	13,061		4,343			14,601		3,299				
WY 2025 (Year 15)	4,149		601					6,700	17,730		5,682			17,950		4,363				
WY 2035 (Year 25)	5,022		1,007					7,378	18,976		6,080			18,651		5,214				
WY 2060 (Year 50)	5,676		1,312					7,887	19,910		6,379			19,177		5,853				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	1,610			1,428		2,215			5,346		1,932		2,287							
WY 2015 (Year 5)	2,898			2,571		4,419			13,061		4,343		6,278							
WY 2025 (Year 15)	4,149			3,726		5,328			17,730		5,682		9,015							
WY 2035 (Year 25)	5,022			4,535		5,619			18,976		6,080		9,725							
WY 2060 (Year 50)	5,676			5,142		5,837			19,910		6,379		10,258							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	1,610		49	1,428		2,215		2,021	5,346		1,932		2,287	6,783		3,299		99	2,981	
WY 2015 (Year 5)	2,898		88	2,571		4,419		4,787	13,061		4,343		6,278	14,601		3,299		99	2,981	
WY 2025 (Year 15)	4,149		601	3,726		5,328		6,700	17,730		5,682		9,015	17,950		4,363		617	3,961	
WY 2035 (Year 25)	5,022		1,007	4,535		5,619		7,378	18,976		6,080		9,725	18,651		5,214		1,032	4,744	
WY 2060 (Year 50)	5,676		1,312	5,142		5,837		7,887	19,910		6,379		10,258	19,177		5,853		1,343	5,332	
Central Valley steelhead																				
WY 2010 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2011 (Year 1)	3,606		315	928	3,606	4,610		2,994	4,680	4,199			3,195	5,046	4,199	7,423		648	1,928	7,423
WY 2015 (Year 5)	6,490		567	1,670	6,490	9,191		6,829	10,371	9,054			8,249	10,873	9,054	7,423		648	1,928	7,423
WY 2025 (Year 15)	8,579		1,531	2,888	8,579	11,033		9,238	13,370	11,359			11,494	13,437	11,359	9,069		1,592	3,042	9,069
WY 2035 (Year 25)	9,962		2,277	3,788	9,962	11,602		10,062	14,227	11,969			12,335	14,009	11,969	10,387		2,348	3,934	10,387
WY 2060 (Year 50)	10,999		2,836	4,463	10,999	12,028		10,681	14,870	12,426			12,966	14,438	12,426	11,375		2,914	4,603	11,375

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 89
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 136.7R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	1,892		21			1,915		1,911	5,920		1,693		2,315	7,476		3,176		-315		
WY 2014 (Year 5)	3,405		38			3,769		4,379	13,237		3,673		5,798	15,034		3,176		-315		
WY 2024 (Year 15)	4,568		495			4,456		5,890	16,911		4,658		7,908	17,636		3,980		77		
WY 2034 (Year 25)	5,346		858			4,659		6,384	17,829		4,937		8,432	18,173		4,624		390		
WY 2059 (Year 50)	5,930		1,131			4,811		6,754	18,517		5,145		8,825	18,575		5,106		625		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	1,892		21					1,911	5,920		1,693			7,476		3,176				
WY 2014 (Year 5)	3,405		38					4,379	13,237		3,673			15,034		3,176				
WY 2024 (Year 15)	4,568		495					5,890	16,911		4,658			17,636		3,980				
WY 2034 (Year 25)	5,346		858					6,384	17,829		4,937			18,173		4,624				
WY 2059 (Year 50)	5,930		1,131					6,754	18,517		5,145			18,575		5,106				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	1,892			402		1,915			5,920		1,693		2,315							
WY 2014 (Year 5)	3,405			723		3,769			13,237		3,673		5,798							
WY 2024 (Year 15)	4,568			1,845		4,456			16,911		4,658		7,908							
WY 2034 (Year 25)	5,346			2,710		4,659			17,829		4,937		8,432							
WY 2059 (Year 50)	5,930			3,359		4,811			18,517		5,145		8,825							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	1,892		21	402		1,915		1,911	5,920		1,693		2,315	7,476		3,176		-315	155	
WY 2014 (Year 5)	3,405		38	723		3,769		4,379	13,237		3,673		5,798	15,034		3,176		-315	155	
WY 2024 (Year 15)	4,568		495	1,845		4,456		5,890	16,911		4,658		7,908	17,636		3,980		77	889	
WY 2034 (Year 25)	5,346		858	2,710		4,659		6,384	17,829		4,937		8,432	18,173		4,624		390	1,476	
WY 2059 (Year 50)	5,930		1,131	3,359		4,811		6,754	18,517		5,145		8,825	18,575		5,106		625	1,916	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	3,804		162	353	3,804	3,909		2,818	5,069	3,661			3,196	5,612	3,661	6,844		-241	-149	6,844
WY 2014 (Year 5)	6,848		291	636	6,848	7,693		6,218	10,575	7,635			7,600	11,296	7,635	6,844		241	-149	6,844
WY 2024 (Year 15)	8,851		1,154	1,817	8,851	9,070		8,101	12,956	9,320			10,073	13,294	9,320	8,087		471	689	8,087
WY 2034 (Year 25)	10,149		1,832	2,733	10,149	9,465		8,695	13,584	9,747			10,688	13,728	9,747	9,081		1,041	1,359	9,081
WY 2059 (Year 50)	11,123		2,340	3,420	11,123	9,762		9,140	14,056	10,067			11,148	14,053	10,067	9,827		1,469	1,661	9,827

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 90
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 136.9R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	2,400		-394			2,867		3,089	9,740		2,608		3,526	11,947		4,700		-856		
WY 2014 (Year 5)	4,319		-709			5,761		7,240	22,375		5,925		9,646	25,167		4,700		-856		
WY 2024 (Year 15)	6,212		21			7,002		10,076	29,274		7,834		13,869	30,510		6,300		-64		
WY 2034 (Year 25)	7,533		636			7,406		11,089	31,108		8,414		14,986	31,631		7,580		569		
WY 2059 (Year 50)	8,525		1,097			7,709		11,850	32,484		8,849		15,824	32,472		8,540		1,044		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	2,400		-394					3,089	9,740		2,608			11,947		4,700				
WY 2014 (Year 5)	4,319		-709					7,240	22,375		5,925			25,167		4,700				
WY 2024 (Year 15)	6,212		21					10,076	29,274		7,834			30,510		6,300				
WY 2034 (Year 25)	7,533		636					11,089	31,108		8,414			31,631		7,580				
WY 2059 (Year 50)	8,525		1,097					11,850	32,484		8,849			32,472		8,540				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	2,400			-1,027		2,867			9,740		2,608		3,526							
WY 2014 (Year 5)	4,319			-1,848		5,761			22,375		5,925		9,646							
WY 2024 (Year 15)	6,212			-237		7,002			29,274		7,834		13,869							
WY 2034 (Year 25)	7,533			1,133		7,406			31,108		8,414		14,986							
WY 2059 (Year 50)	8,525			2,161		7,709			32,484		8,849		15,824							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	2,400		-394	-1,027		2,867		3,089	9,740		2,608		3,526	11,947		4,700		-856	-1,988	
WY 2014 (Year 5)	4,319		-709	-1,848		5,761		7,240	22,375		5,925		9,646	25,167		4,700		-856	-1,988	
WY 2024 (Year 15)	6,212		21	-237		7,002		10,076	29,274		7,834		13,869	30,510		6,300		-64	-305	
WY 2034 (Year 25)	7,533		636	1,133		7,406		11,089	31,108		8,414		14,986	31,631		7,580		569	1,041	
WY 2059 (Year 50)	8,525		1,097	2,161		7,709		11,850	32,484		8,849		15,824	32,472		8,540		1,044	2,051	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	5,075		-459	-1,155	5,075	6,015		4,570	8,187	5,612			4,987	8,947	5,612	10,140		-997	-2,292	10,140
WY 2014 (Year 5)	9,135		-827	-2,078	9,135	12,066		10,308	17,471	12,273			12,764	18,816	12,273	10,140		-997	-2,292	10,140
WY 2024 (Year 15)	12,357		554	-352	12,357	14,586		13,853	21,919	15,574			17,744	22,881	15,574	12,693		457	-453	12,693
WY 2034 (Year 25)	14,528		1,695	1,121	14,528	15,377		15,074	23,182	16,464			19,057	23,792	16,464	14,736		1,620	1,018	14,736
WY 2059 (Year 50)	16,156		2,551	2,225	16,156	15,970		15,989	24,129	17,132			20,042	24,474	17,132	16,268		2,493	2,121	16,268

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 91
SAM results showing wetted-area weighted relative response (square feet) at Sutter Bypass LM 0.4E.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2009 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2010 (Year 1)	420		-277			583		788	1,721		472		772	2,092		846		-551		
WY 2014 (Year 5)	756		-498			1,050		1,438	3,797		850		1,390	3,934		846		-551		
WY 2024 (Year 15)	1,403		-283			1,429		2,266	5,872		1,473		2,635	5,616		1,440		-297		
WY 2034 (Year 25)	1,886		-88			1,685		2,854	6,974		1,933		3,569	6,694		1,916		-94		
WY 2059 (Year 50)	2,249		58			1,877		3,295	7,802		2,278		4,269	7,502		2,272		59		
Central Valley fall-run chinook salmon																				
WY 2009 (Year 0)	0		0					0	0		0			0		0				
WY 2010 (Year 1)	420		-277					788	1,721		472			2,092		846				
WY 2014 (Year 5)	756		-498					1,438	3,797		850			3,934		846				
WY 2024 (Year 15)	1,403		-283					2,266	5,872		1,473			5,616		1,440				
WY 2034 (Year 25)	1,886		-88					2,854	6,974		1,933			6,694		1,916				
WY 2059 (Year 50)	2,249		58					3,295	7,802		2,278			7,502		2,272				
Central Valley late fall-run chinook salmon																				
WY 2009 (Year 0)	0			0		0			0		0		0							
WY 2010 (Year 1)	420			-1,981		583			1,721		472		772							
WY 2014 (Year 5)	756			-3,566		1,050			3,797		850		1,390							
WY 2024 (Year 15)	1,403			-3,236		1,429			5,872		1,473		2,635							
WY 2034 (Year 25)	1,886			-2,814		1,685			6,974		1,933		3,569							
WY 2059 (Year 50)	2,249			-2,497		1,877			7,802		2,278		4,269							
Sacramento River winter-run chinook salmon																				
WY 2009 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2010 (Year 1)	420		-277	-1,981		583		788	1,721		472		772	2,092		846		-551	-3,969	
WY 2014 (Year 5)	756		-498	-3,566		1,050		1,438	3,797		850		1,390	3,934		846		-551	-3,969	
WY 2024 (Year 15)	1,403		-283	-3,236		1,429		2,266	5,872		1,473		2,635	5,616		1,440		-297	-3,371	
WY 2034 (Year 25)	1,886		-88	-2,814		1,685		2,854	6,974		1,933		3,569	6,694		1,916		-94	-2,892	
WY 2059 (Year 50)	2,249		58	-2,497		1,877		3,295	7,802		2,278		4,269	7,502		2,272		59	-2,534	
Central Valley steelhead																				
WY 2009 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2010 (Year 1)	982		-429	-1,470	982	1,281		1,175	1,899	1,074			1,113	1,945	1,074	1,978		-854	-2,942	1,978
WY 2014 (Year 5)	1,768		-772	-2,647	1,768	2,306		2,144	3,699	1,933			2,004	3,531	1,933	1,978		-854	-2,942	1,978
WY 2024 (Year 15)	2,832		-351	-2,164	2,832	3,074		3,208	5,120	3,004			3,525	4,897	3,004	2,917		-373	-2,259	2,917
WY 2034 (Year 25)	3,605		20	-1,661	3,605	3,586		3,946	5,937	3,775			4,653	5,806	3,775	3,668		12	-1,713	3,668
WY 2059 (Year 50)	4,184		296	-1,283	4,184	3,970		4,500	6,550	4,353			5,499	6,492	4,353	4,232		301	-1,303	4,232

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

Table 92
SAM results showing wetted-area weighted relative response (square feet) at Sacramento River RM 157.7R.

Focus Fish Species and Scenario	Fall (September-November)					Winter (December-February)					Spring (March-May)					Summer (June-August)				
	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat	Adult Upstream Migration	Spawning and Incubation	Juvenile Rearing	Smolt Outmigration	Adult Habitat
Central Valley spring-run chinook salmon																				
WY 2010 (Year 0)	0		0			0		0	0		0		0	0		0		0		
WY 2011 (Year 1)	-1,142		-2,437			-174		2,830	4,168		-875		3,743	8,918		-2,327		-4,987		
WY 2015 (Year 5)	-2,056		-4,387			363		7,446	13,463		-346		10,345	18,825		-2,327		-4,987		
WY 2025 (Year 15)	-794		-4,097			1,274		11,061	20,726		1,066		14,882	22,847		-885		-4,359		
WY 2035 (Year 25)	306		-3,669			1,612		12,316	22,627		1,529		16,047	23,687		268		-3,857		
WY 2060 (Year 50)	1,131		-3,349			1,865		13,257	24,053		1,876		16,922	24,317		1,133		-3,480		
Central Valley fall-run chinook salmon																				
WY 2010 (Year 0)	0		0					0	0		0			0		0				
WY 2011 (Year 1)	-1,142		-2,437					2,830	4,168		-875			8,918		-2,327				
WY 2015 (Year 5)	-2,056		-4,387					7,446	13,463		-346			18,825		-2,327				
WY 2025 (Year 15)	-794		-4,097					11,061	20,726		1,066			22,847		-885				
WY 2035 (Year 25)	306		-3,669					12,316	22,627		1,529			23,687		268				
WY 2060 (Year 50)	1,131		-3,349					13,257	24,053		1,876			24,317		1,133				
Central Valley late fall-run chinook salmon																				
WY 2010 (Year 0)	0			0		0			0		0		0							
WY 2011 (Year 1)	-1,142			-4,493		-174			4,168		-875		3,743							
WY 2015 (Year 5)	2,056			-8,088		363			13,463		-346		10,345							
WY 2025 (Year 15)	-794			-7,953		1,274			20,726		1,066		14,882							
WY 2035 (Year 25)	306			-7,486		1,612			22,627		1,529		16,047							
WY 2060 (Year 50)	1,131			-7,136		1,865			24,053		1,876		16,922							
Sacramento River winter-run chinook salmon																				
WY 2010 (Year 0)	0		0	0		0		0	0		0		0	0		0		0	0	
WY 2011 (Year 1)	-1,142		-2,437	-4,493		-174		2,830	4,168		-875		3,743	8,918		-2,327		-4,987	-9,196	
WY 2015 (Year 5)	-2,056		-4,387	-8,088		363		7,446	13,463		-346		10,345	18,825		-2,327		-4,987	-9,196	
WY 2025 (Year 15)	-794		-4,097	-7,953		1,274		11,061	20,726		1,066		14,882	22,847		-885		-4,359	-8,446	
WY 2035 (Year 25)	306		-3,669	-7,486		1,612		12,316	22,627		1,529		16,047	23,687		268		-3,857	-7,846	
WY 2060 (Year 50)	1,131		-3,349	-7,136		1,865		13,257	24,053		1,876		16,922	24,317		1,133		-3,480	-7,396	
Central Valley steelhead																				
WY 2010 (Year 0)	0		0	0	0	0		0	0	0			0	0	0	0		0	0	0
WY 2011 (Year 1)	-1,246		-3,352	-4,830	-1,246	-390		3,601	3,566	-1,052			4,349	5,506	-1,052	-2,544		-6,859	-9,879	-2,544
WY 2015 (Year 5)	-2,244		-6,034	-8,694	-2,244	662		9,243	9,696	62			11,741	11,994	62	-2,544		-6,859	-9,879	-2,544
WY 2025 (Year 15)	-443		-5,377	-8,318	-443	2,448		13,459	14,035	2,209			16,723	14,935	2,209	-538		-5,733	-8,837	-538
WY 2035 (Year 25)	1,097		-4,583	-7,631	1,097	3,088		14,887	15,275	2,837			18,014	15,597	2,837	1,067		-4,831	-8,004	1,067
WY 2060 (Year 50)	2,252		-3,988	-7,115	2,252	3,569		15,958	16,205	3,308			18,963	16,094	3,308	2,271		-4,156	-7,379	2,771

Notes:
1 Dark shading represents seasons in which various life stages are not found in the modeled reach of the Sacramento River
2 Results calculated from time-averaged relative responses (with minus without project) to changes in each of six habitat variables used in the SAM (USACE 2006b)

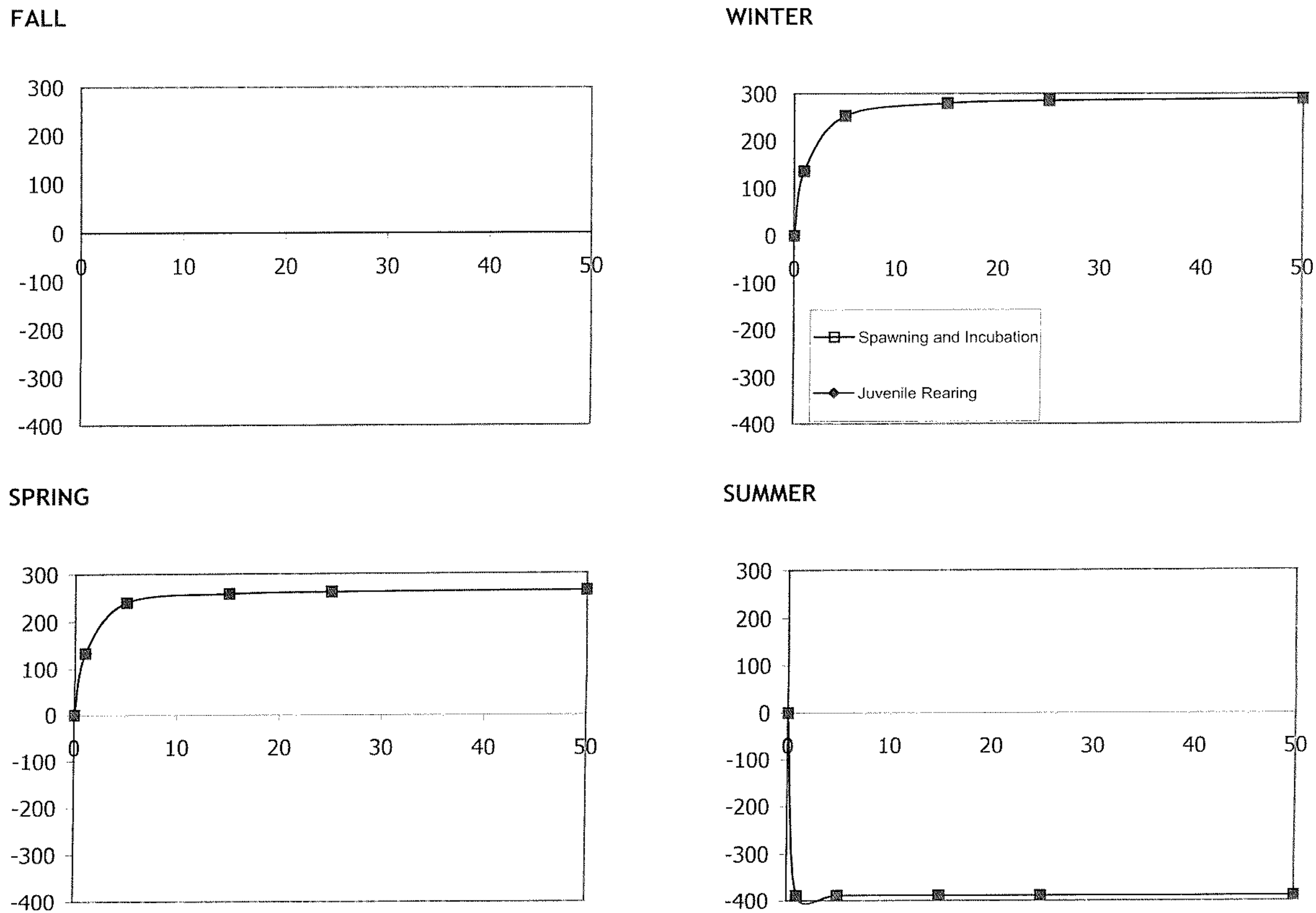

Figure 10. SAM results showing bankline weighted relative response (feet) for delta smelt at site Sacramento River RM 26.0L.

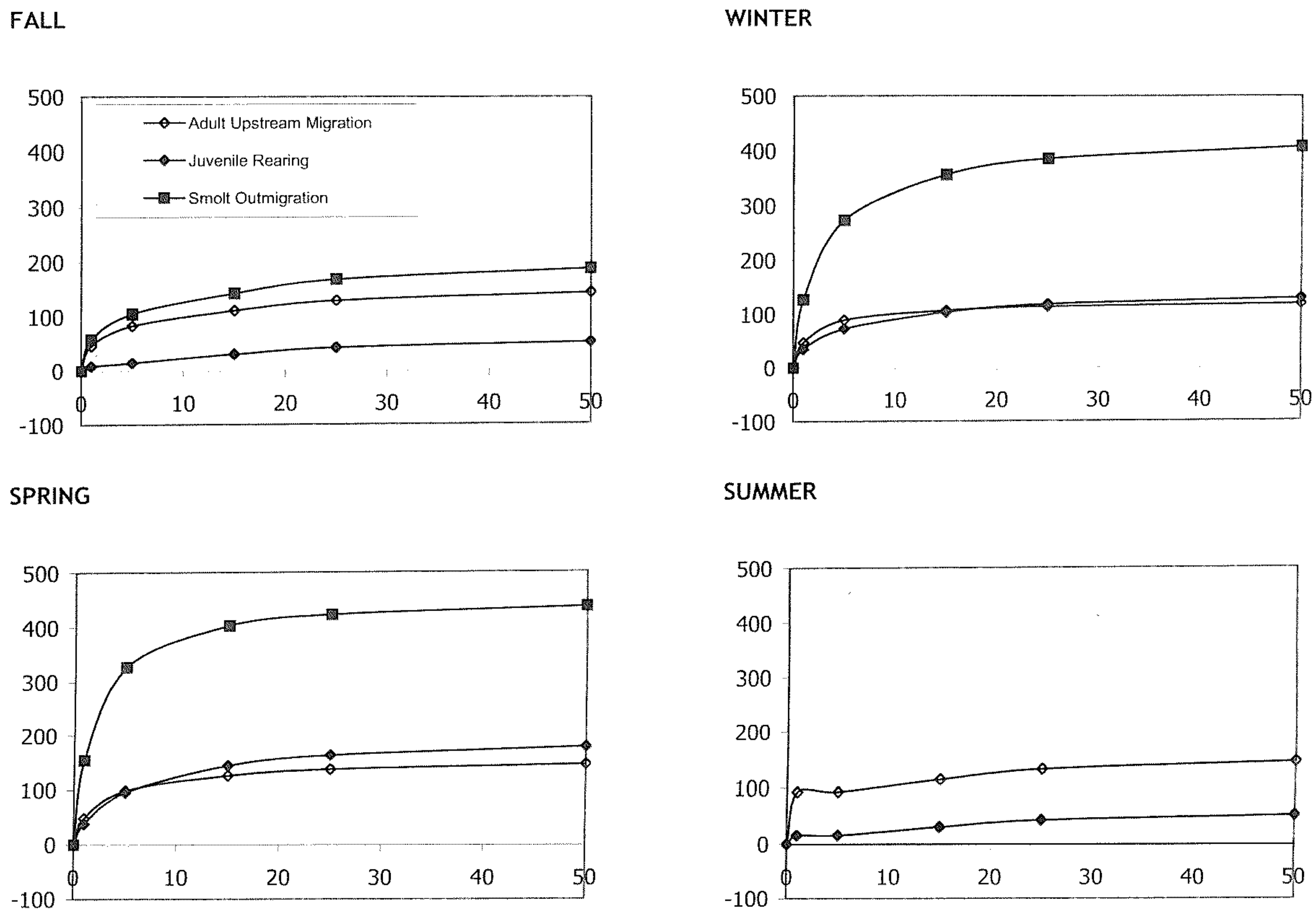

Figure 11. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 35.4L.

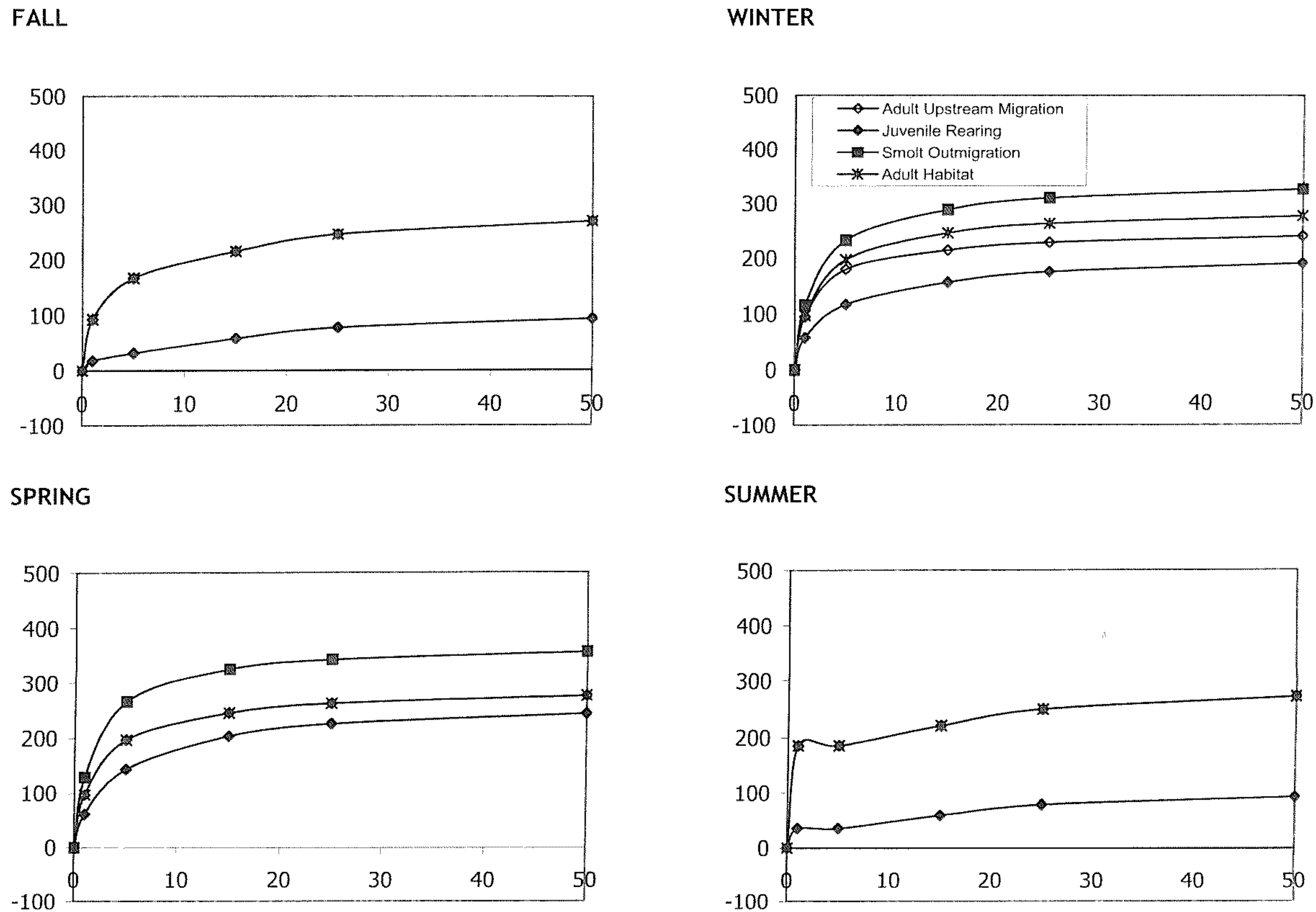

Figure 12. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 35.4L.

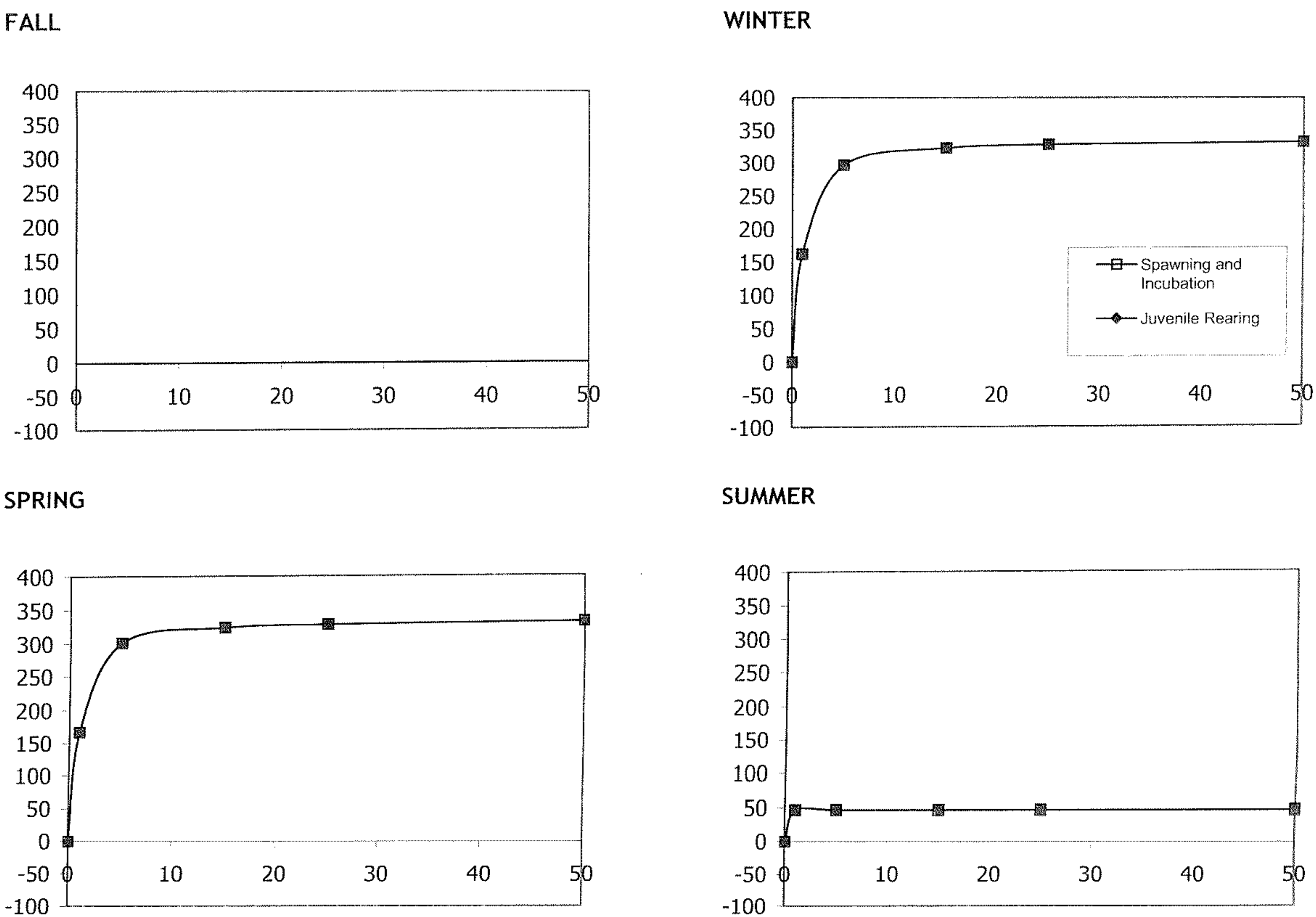

Figure 13. SAM results showing bankline weighted relative response (feet) for delta smelt at site Sacramento River RM 35.4L.

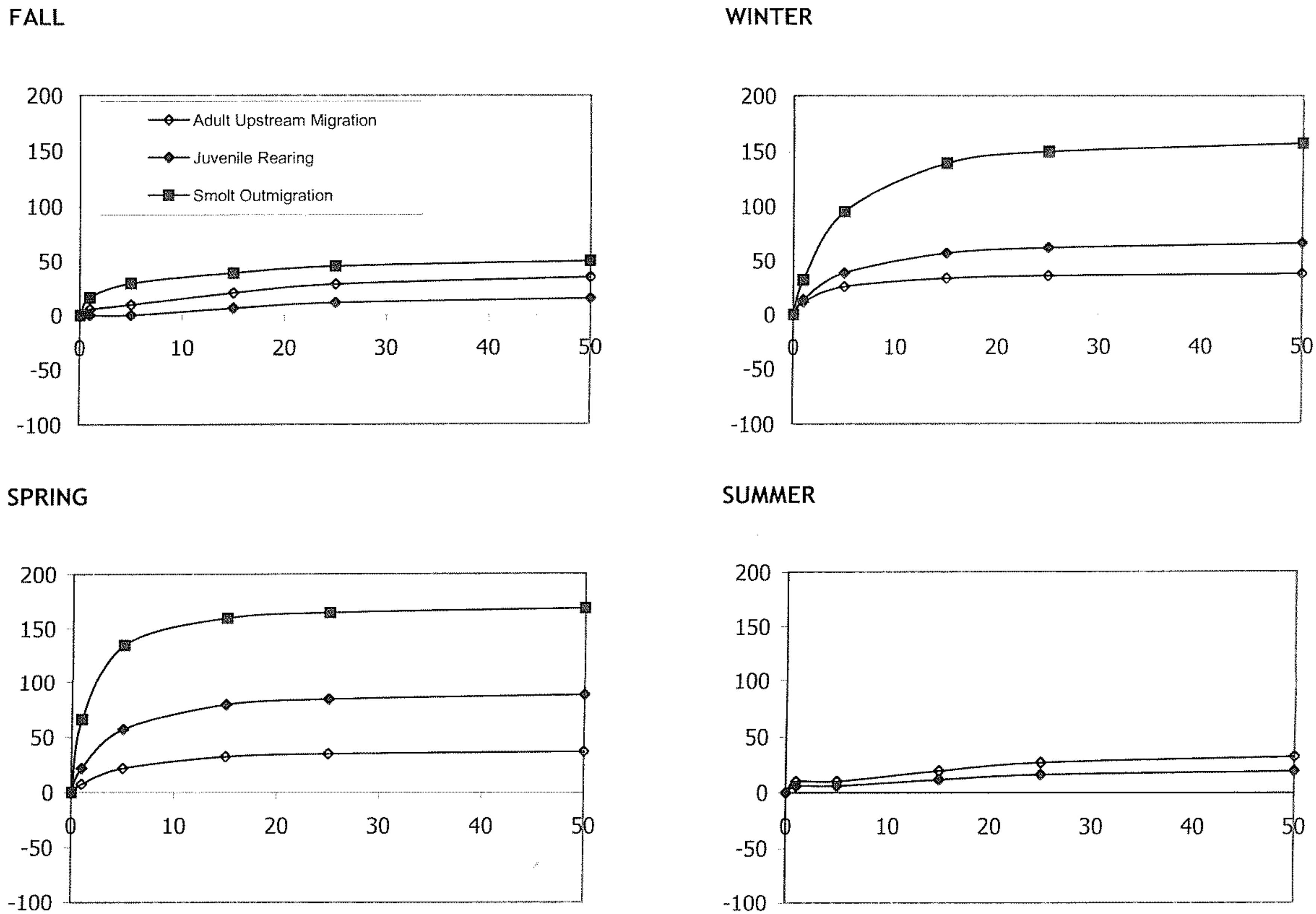

Figure 17. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Lower American River RM 10.0L.

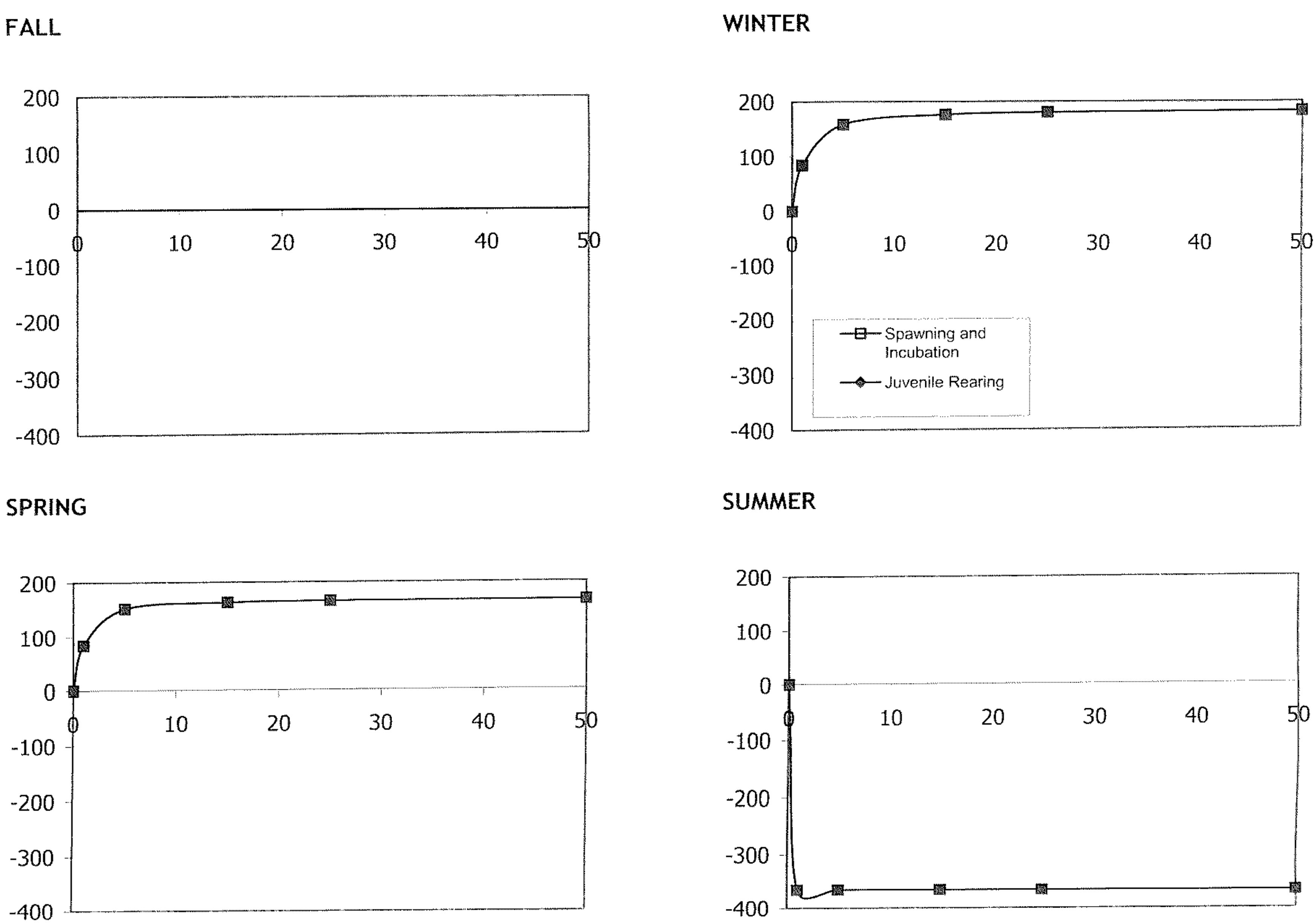

Figure 16. SAM results showing bankline weighted relative response (feet) for delta smelt at site Sacramento River RM 41.9R.

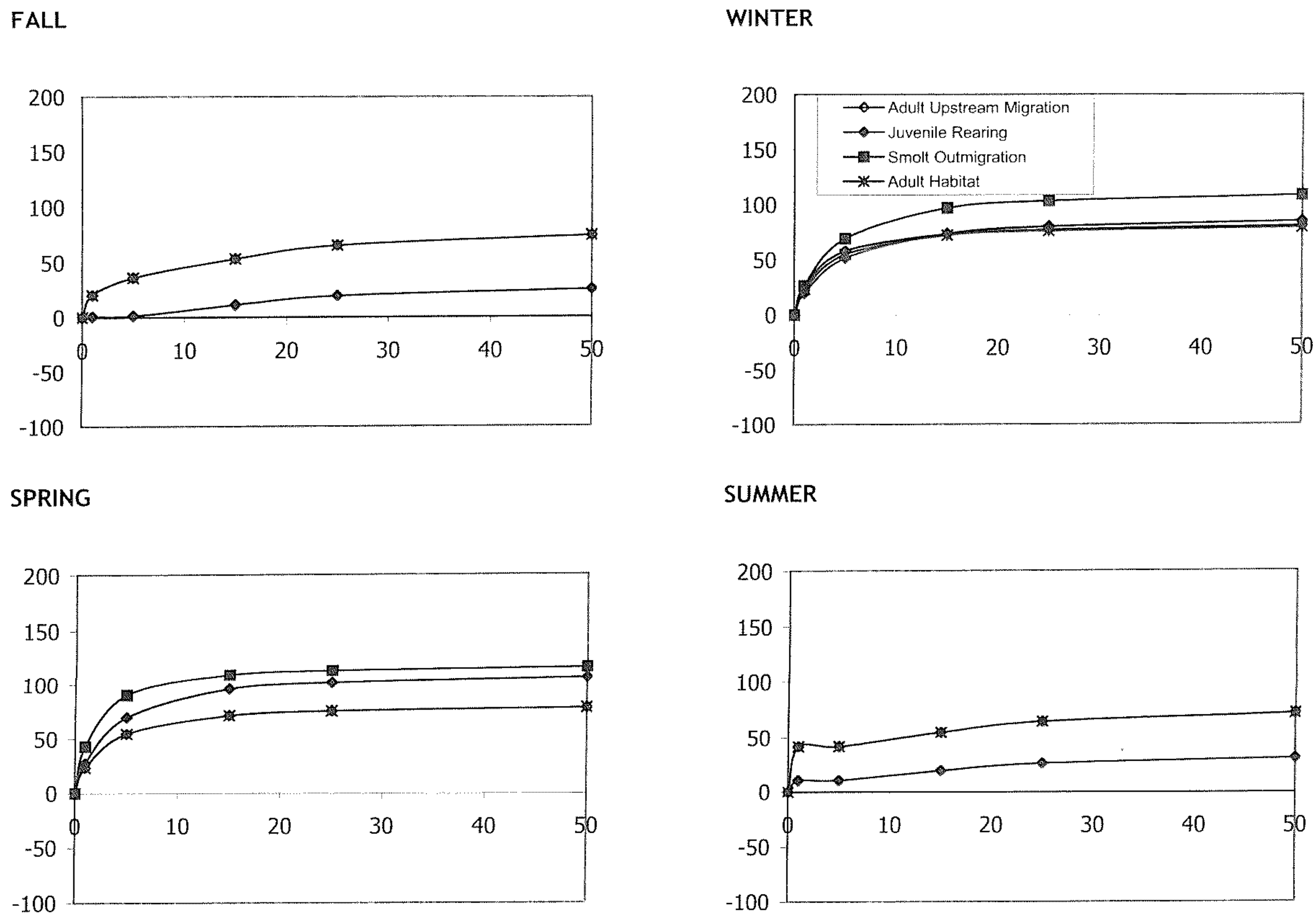

Figure 18. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Lower American River RM 10.0L.

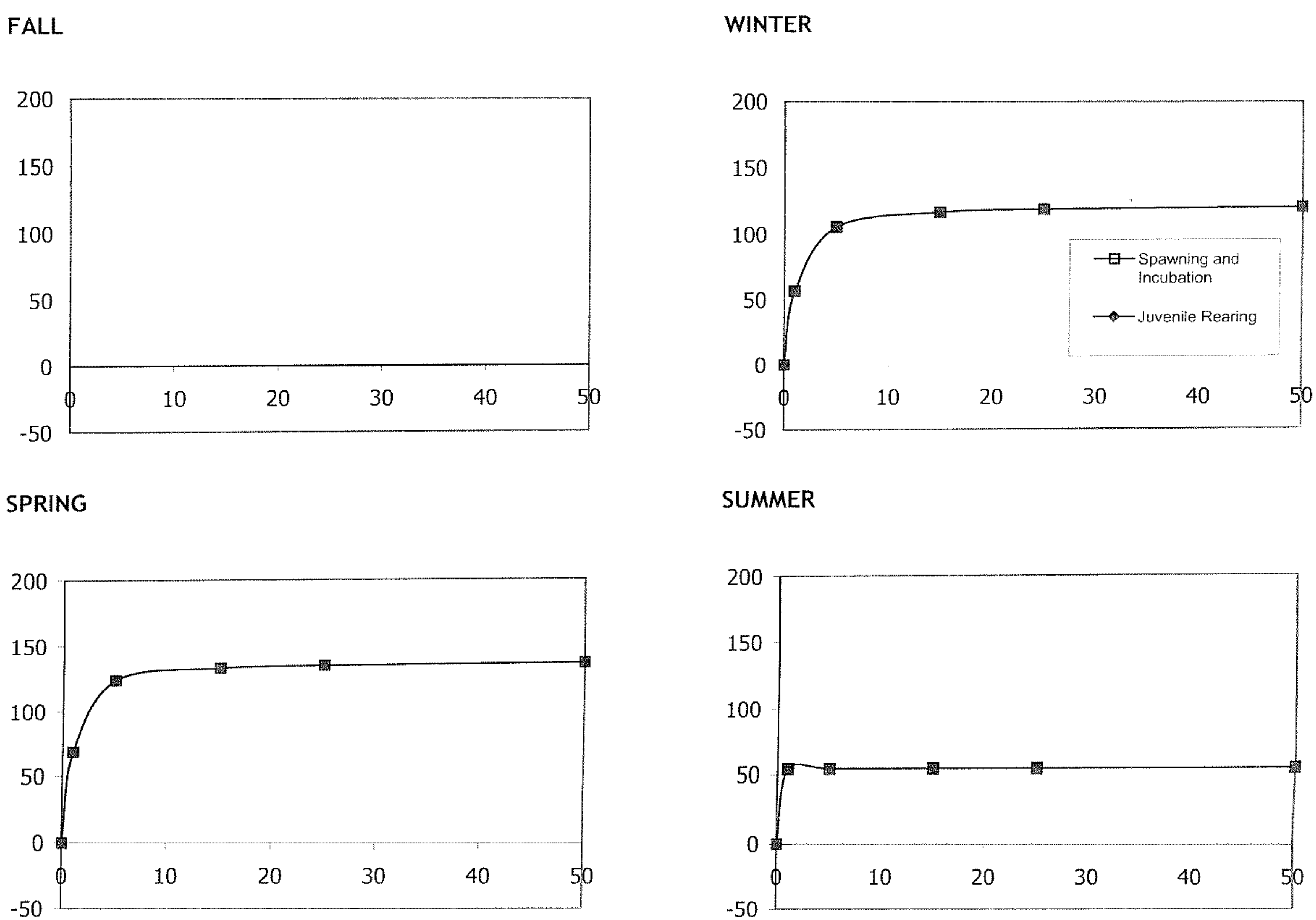

Figure 19. SAM results showing bankline weighted relative response (feet) for delta smelt at site Lower American River RM 10.0L.

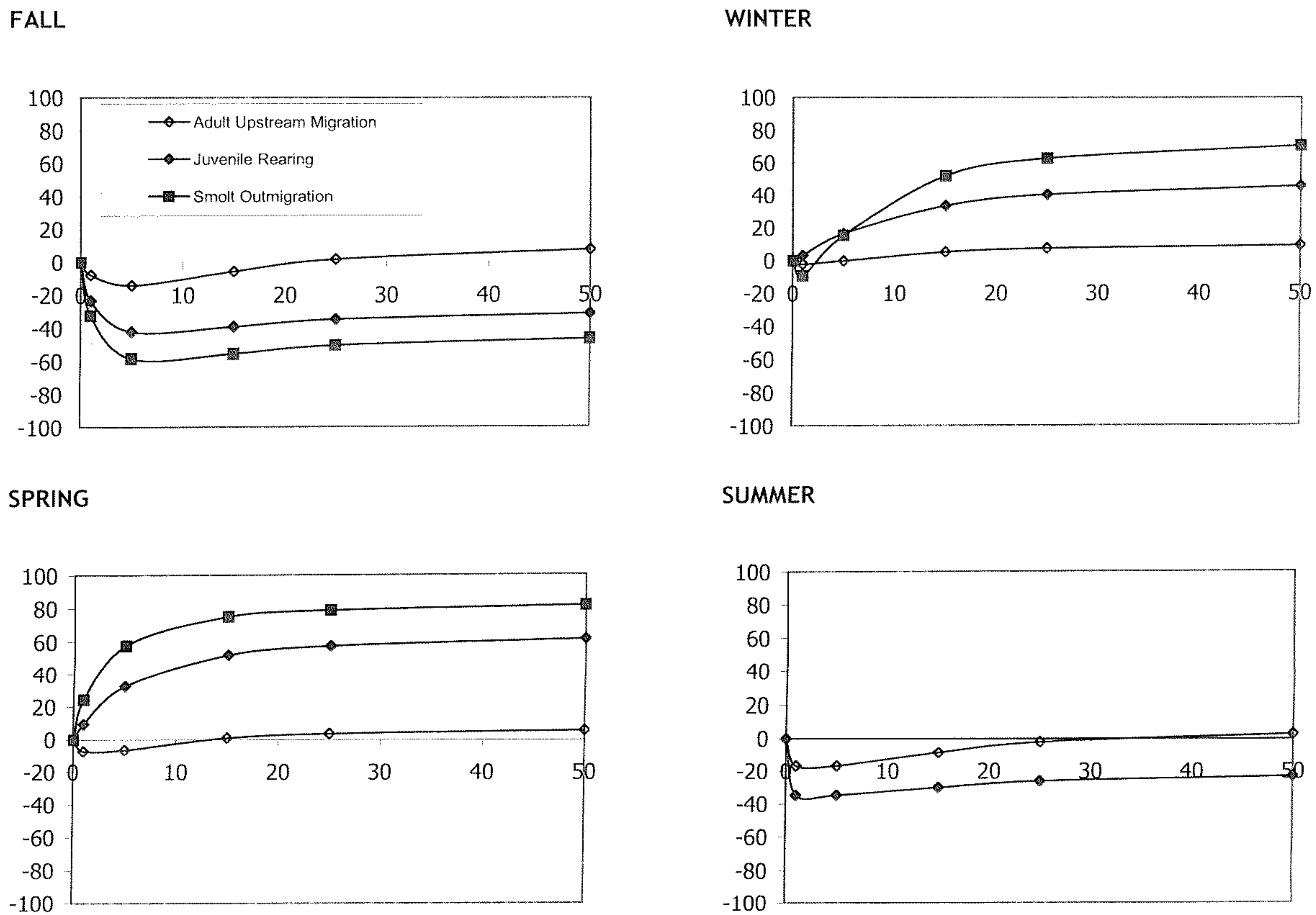

Figure 20. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Lower American River RM 10.6L.

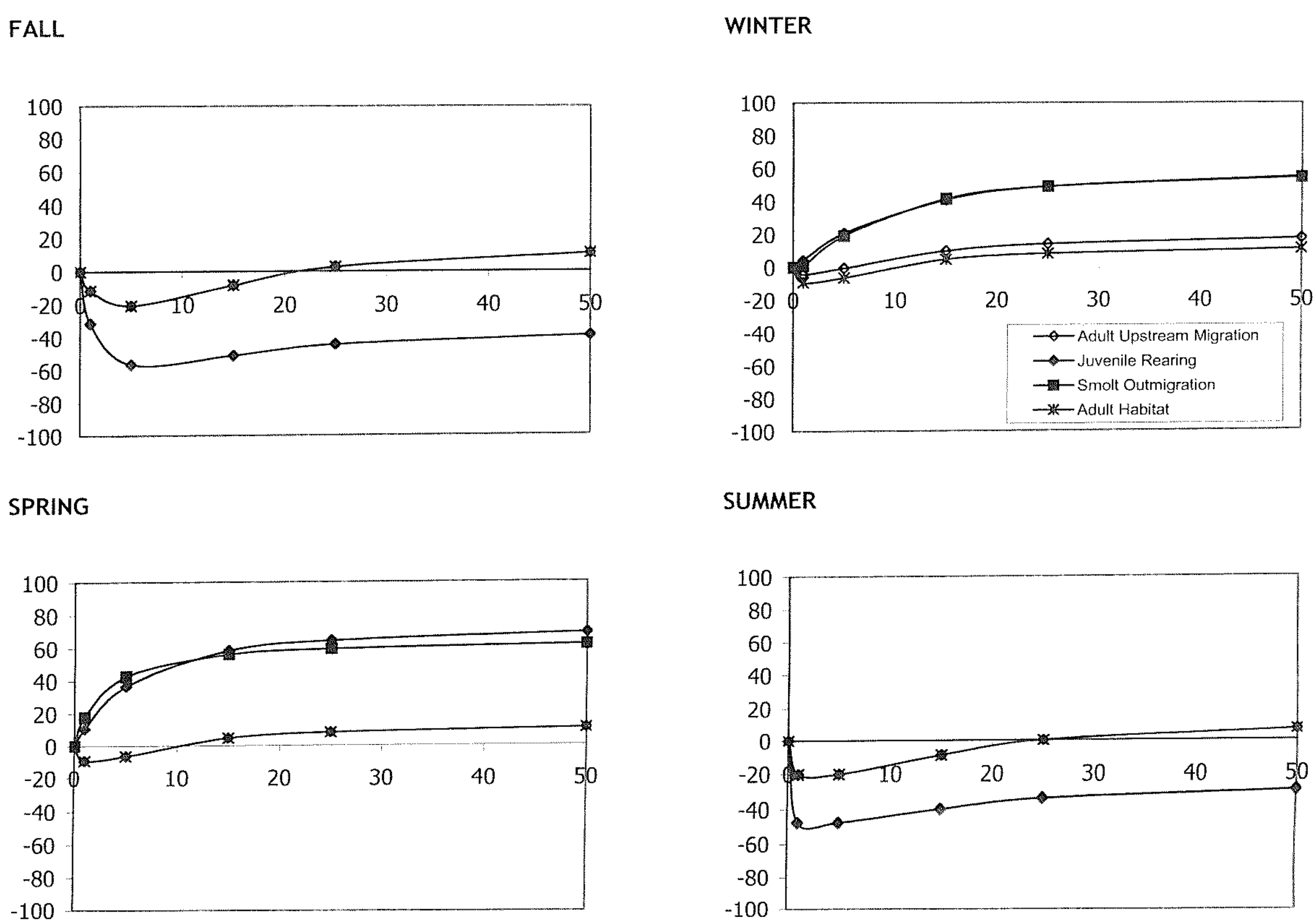

Figure 21. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Lower American River RM 10.6L.

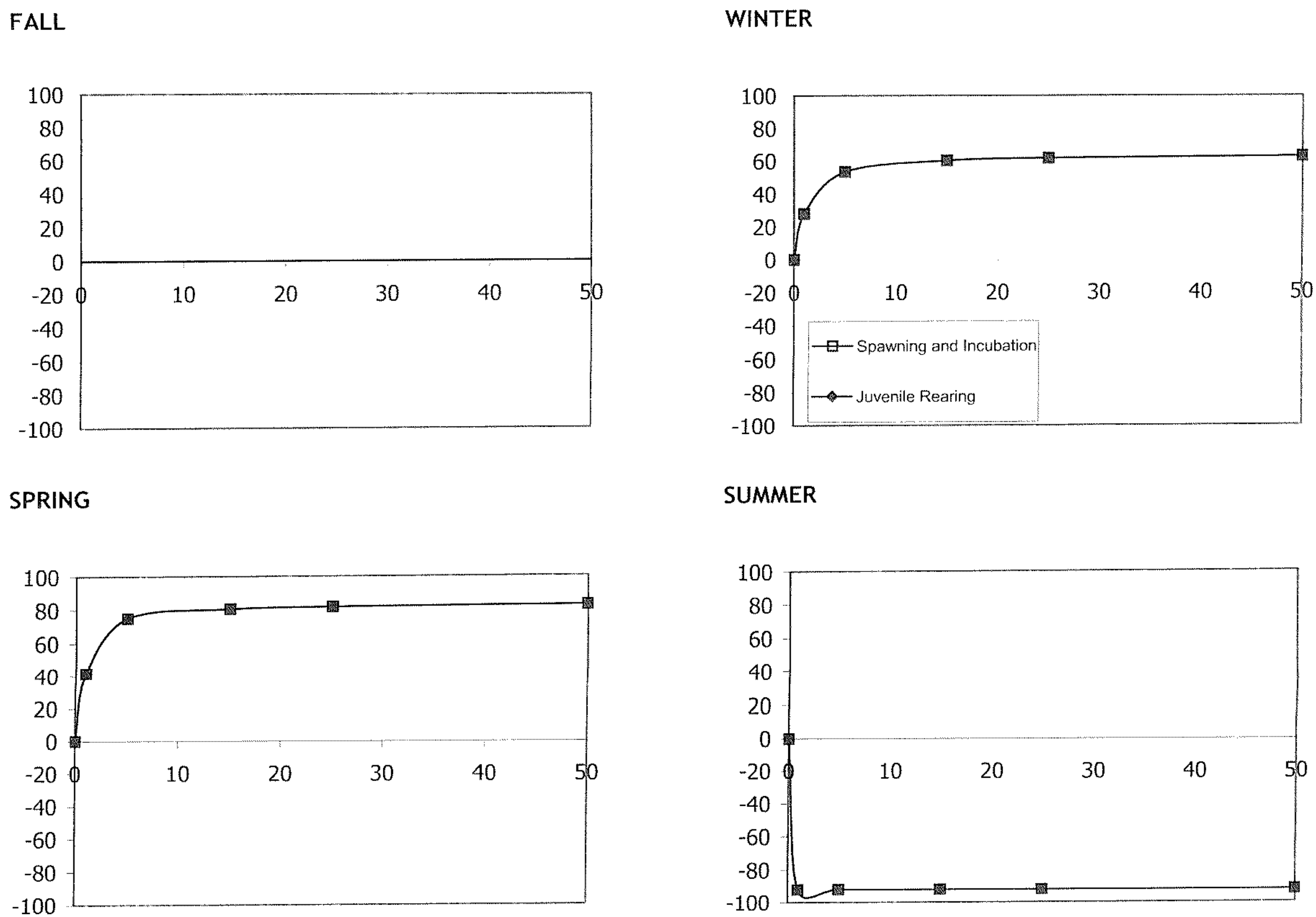

Figure 22. SAM results showing bankline weighted relative response (feet) for delta smelt at site Lower American River RM 10.6L.

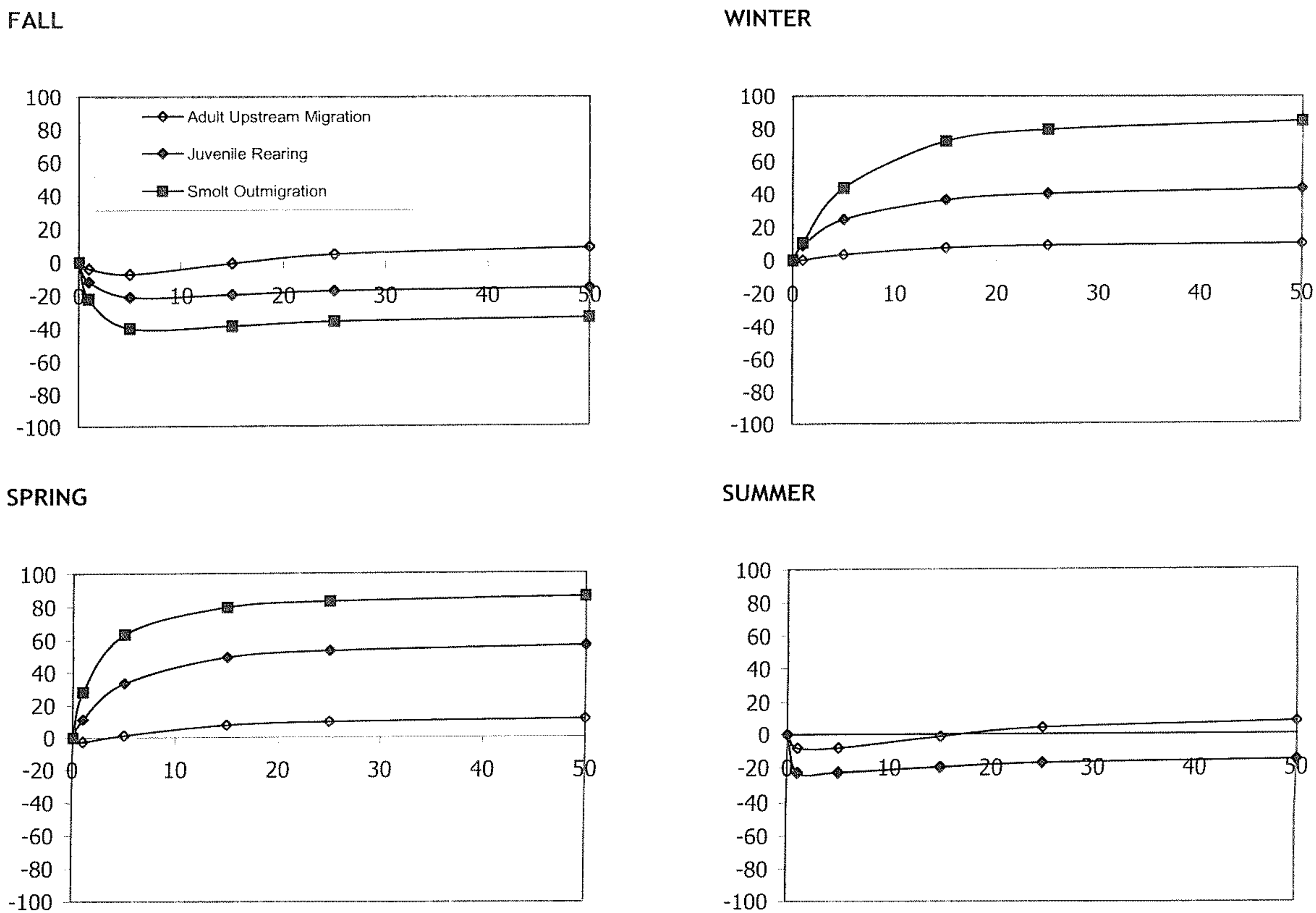

Figure 23. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 71.3R.

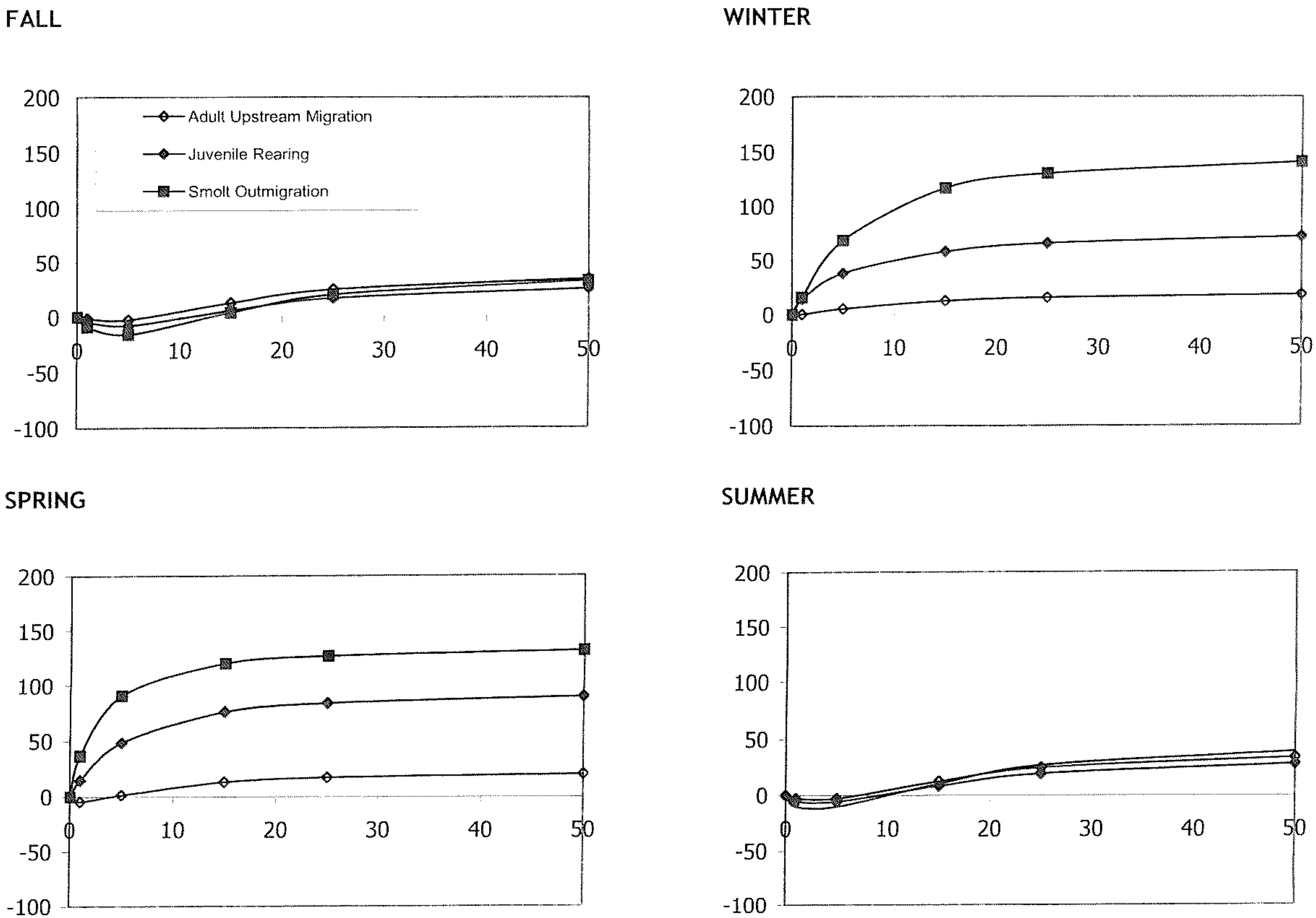

Figure 36. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Feather River RM 5.5L.

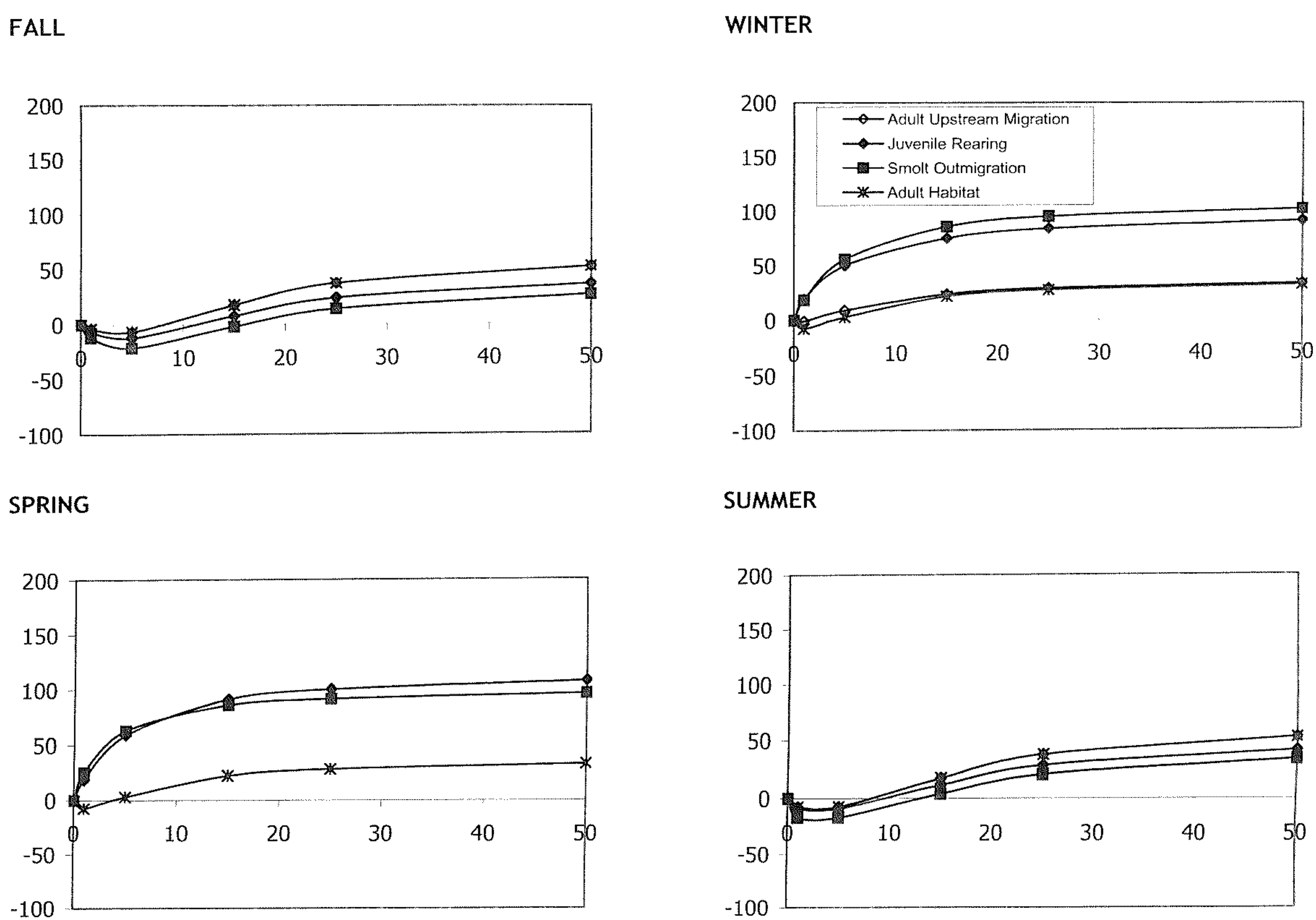

Figure 37. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Feather River RM 5.5L.

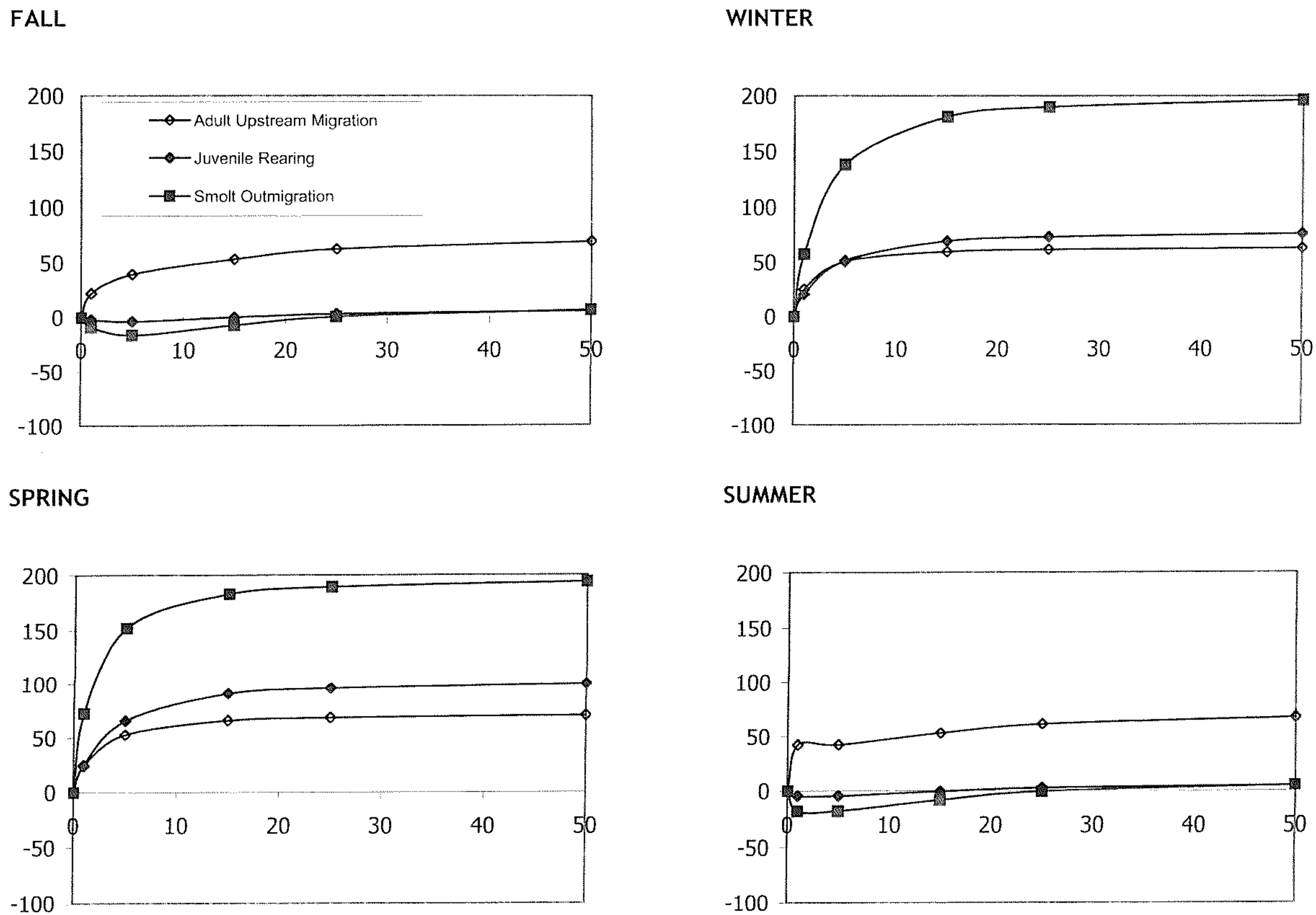

Figure 38. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Feather River RM 7.0L.

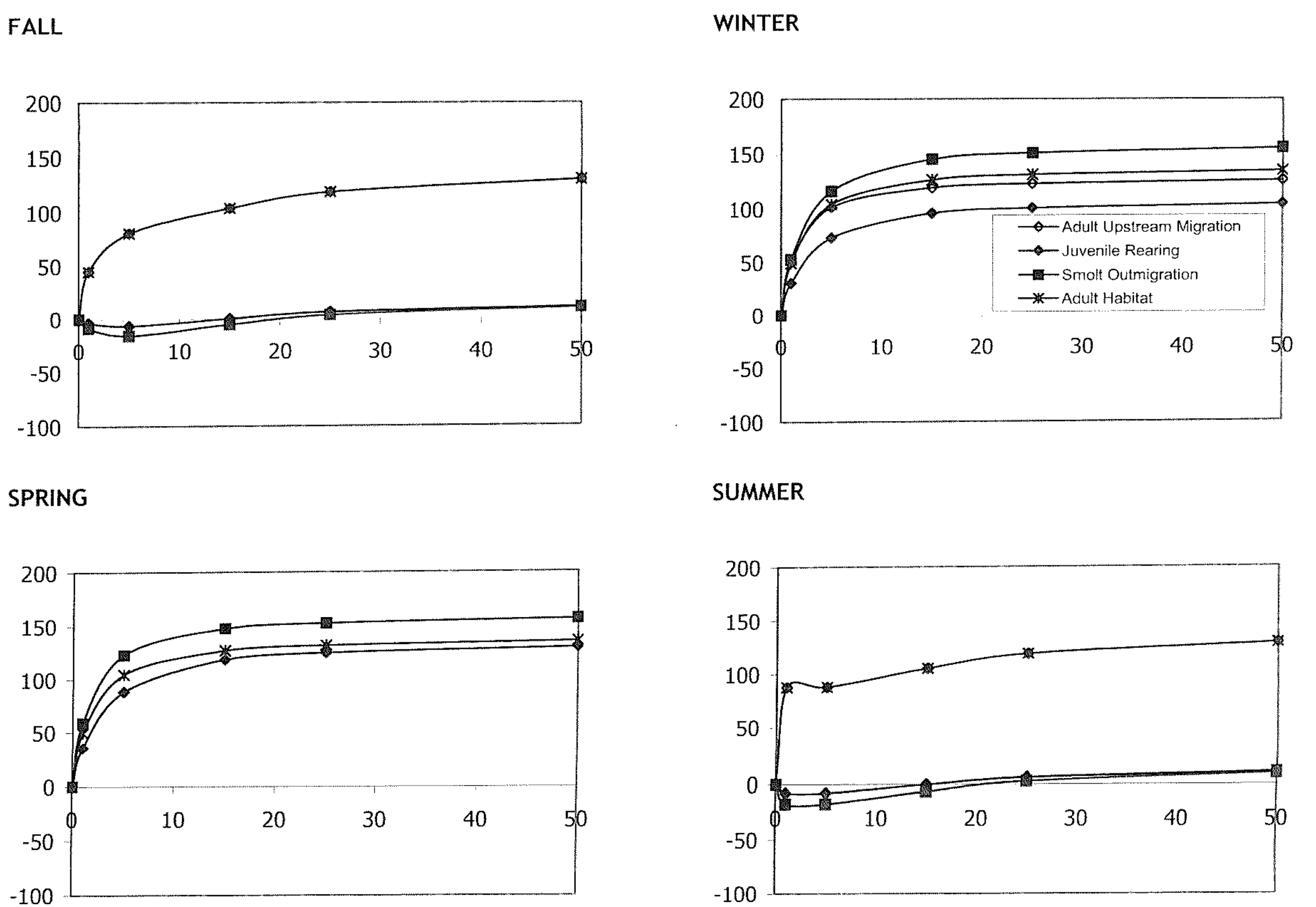

Figure 39. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Feather River RM 7.0L.

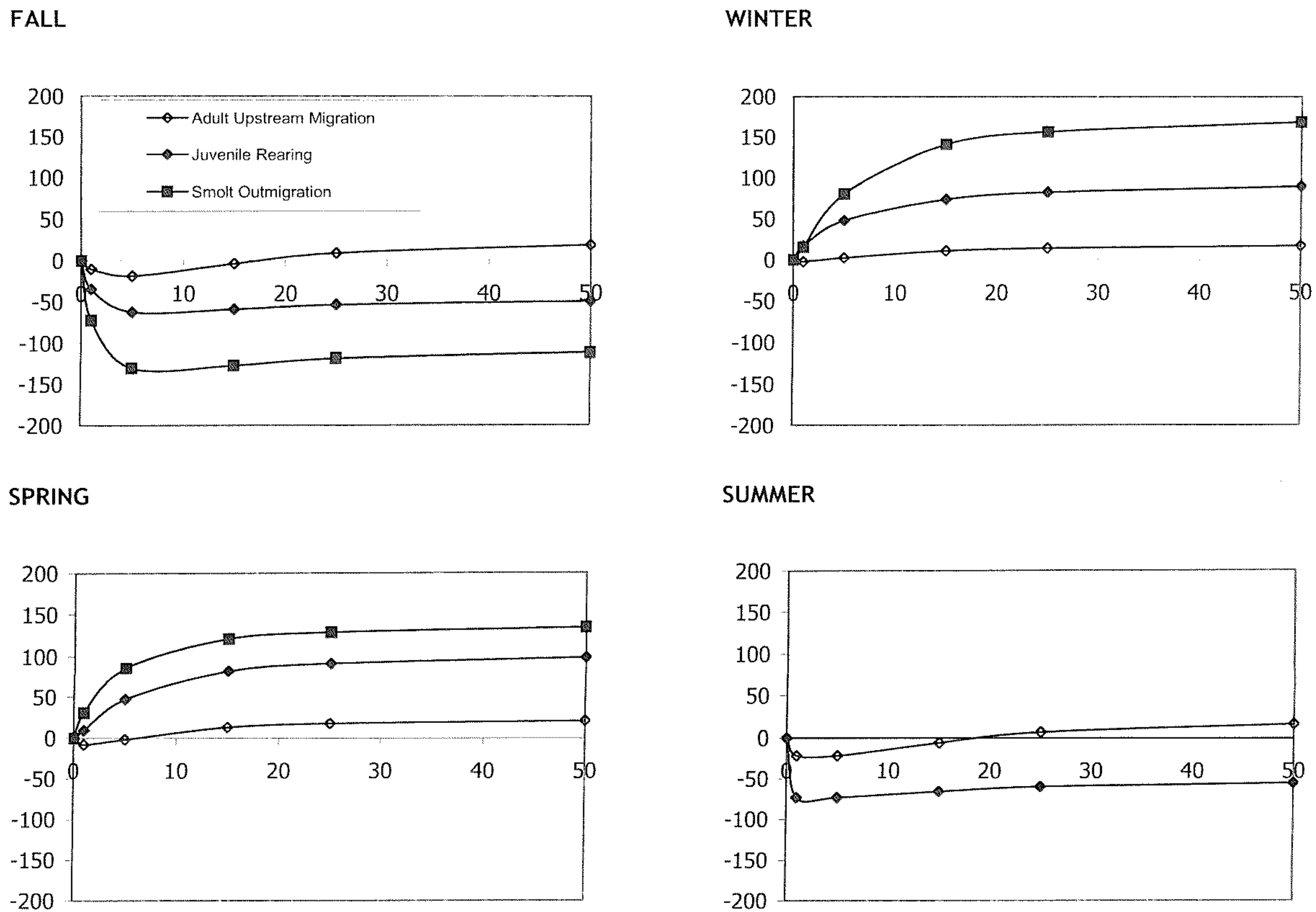

Figure 26. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 73.5L.

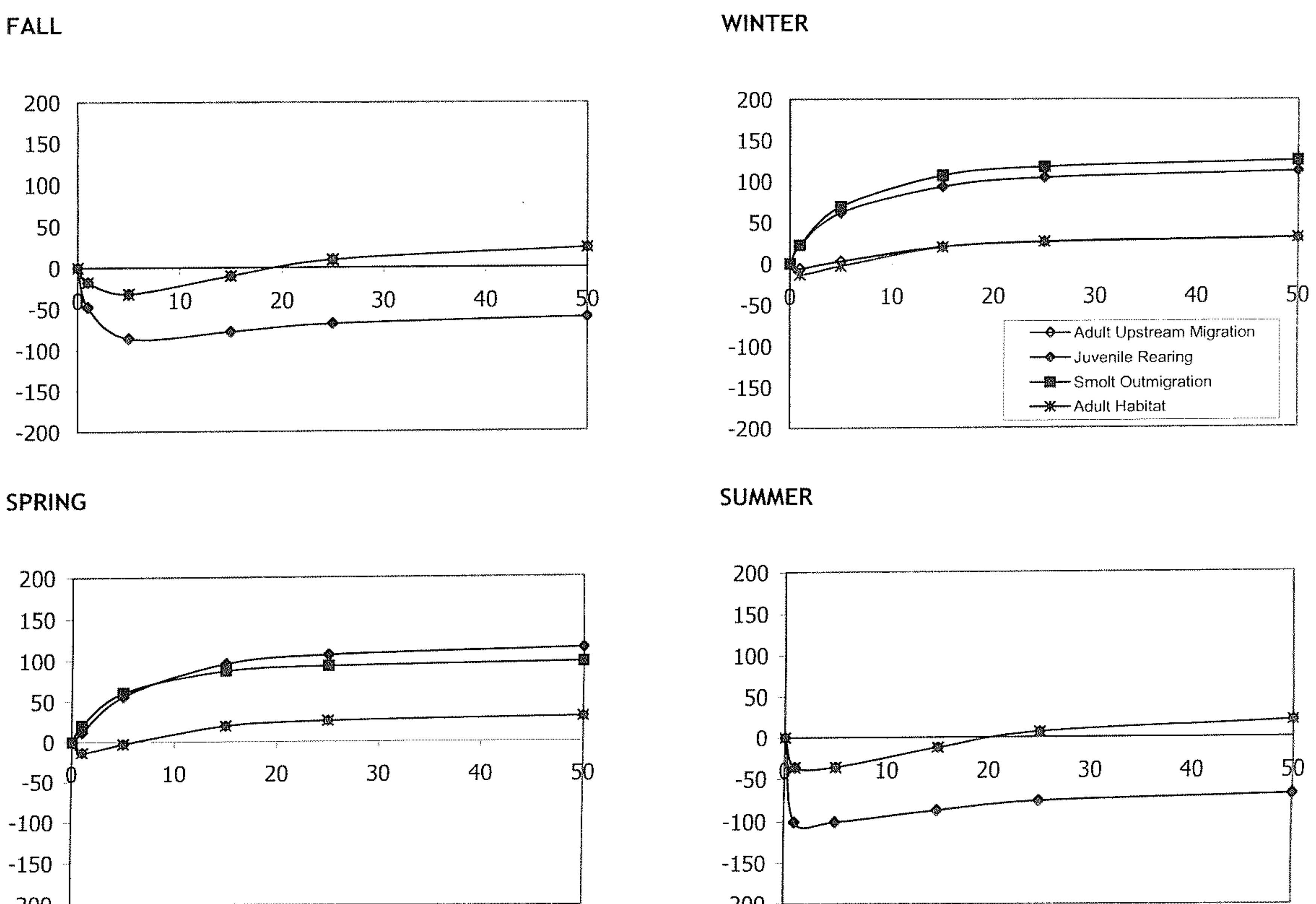

Figure 27. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 73.5L.

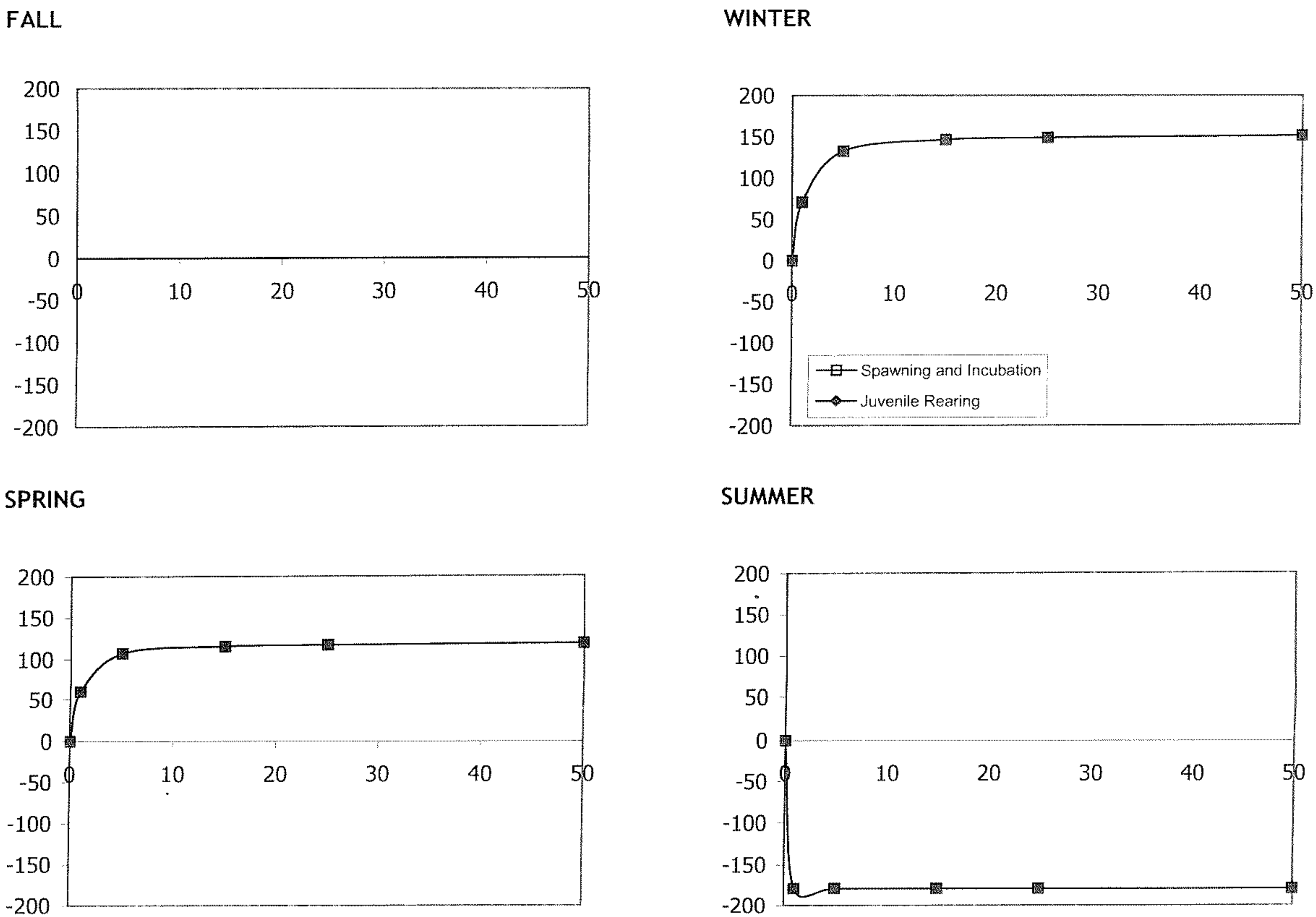

Figure 28. SAM results showing bankline weighted relative response (feet) for delta smelt at site Sacramento River RM 73.5L.

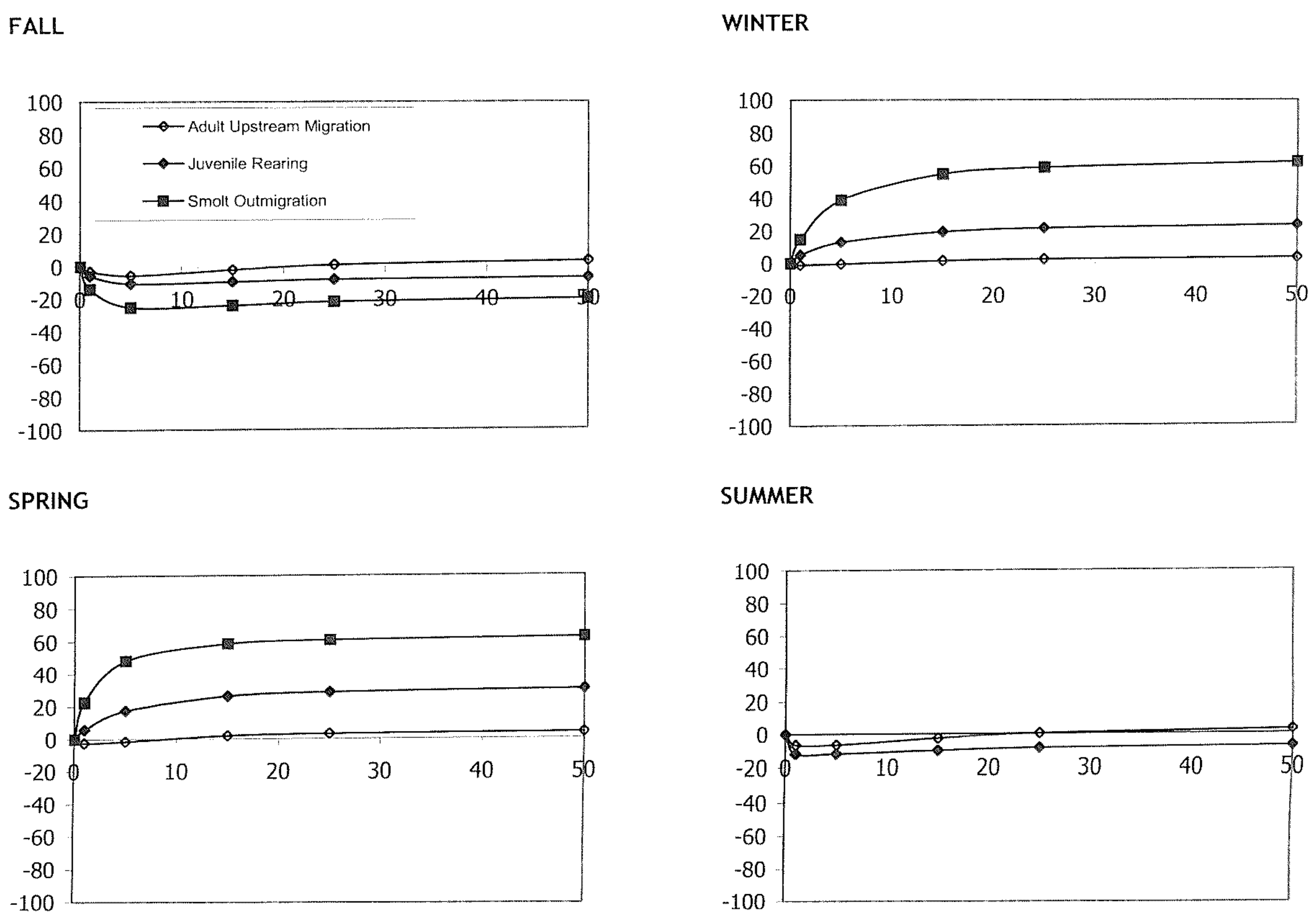

Figure 29. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 78.8L.

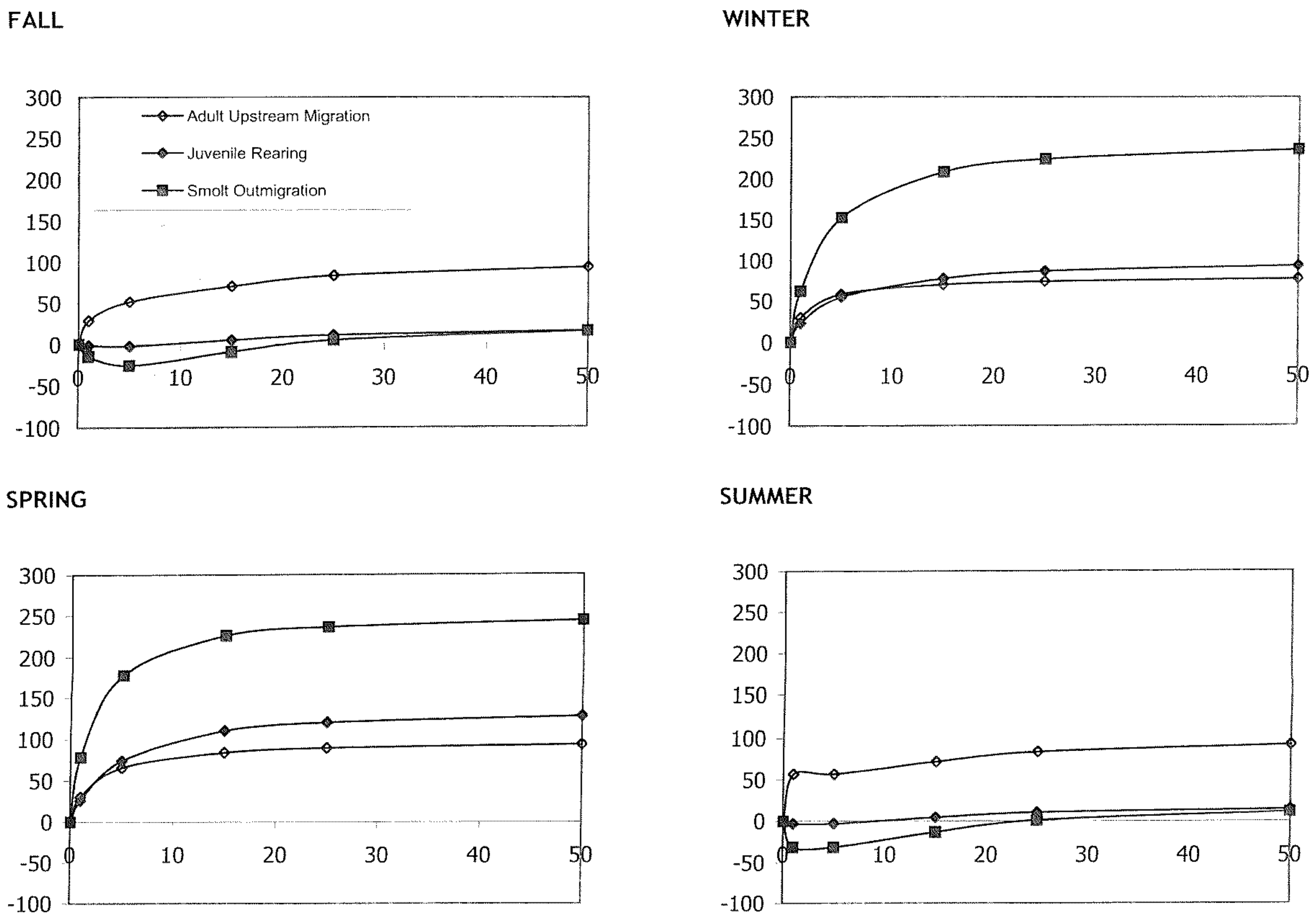

Figure 40. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 87.0L.

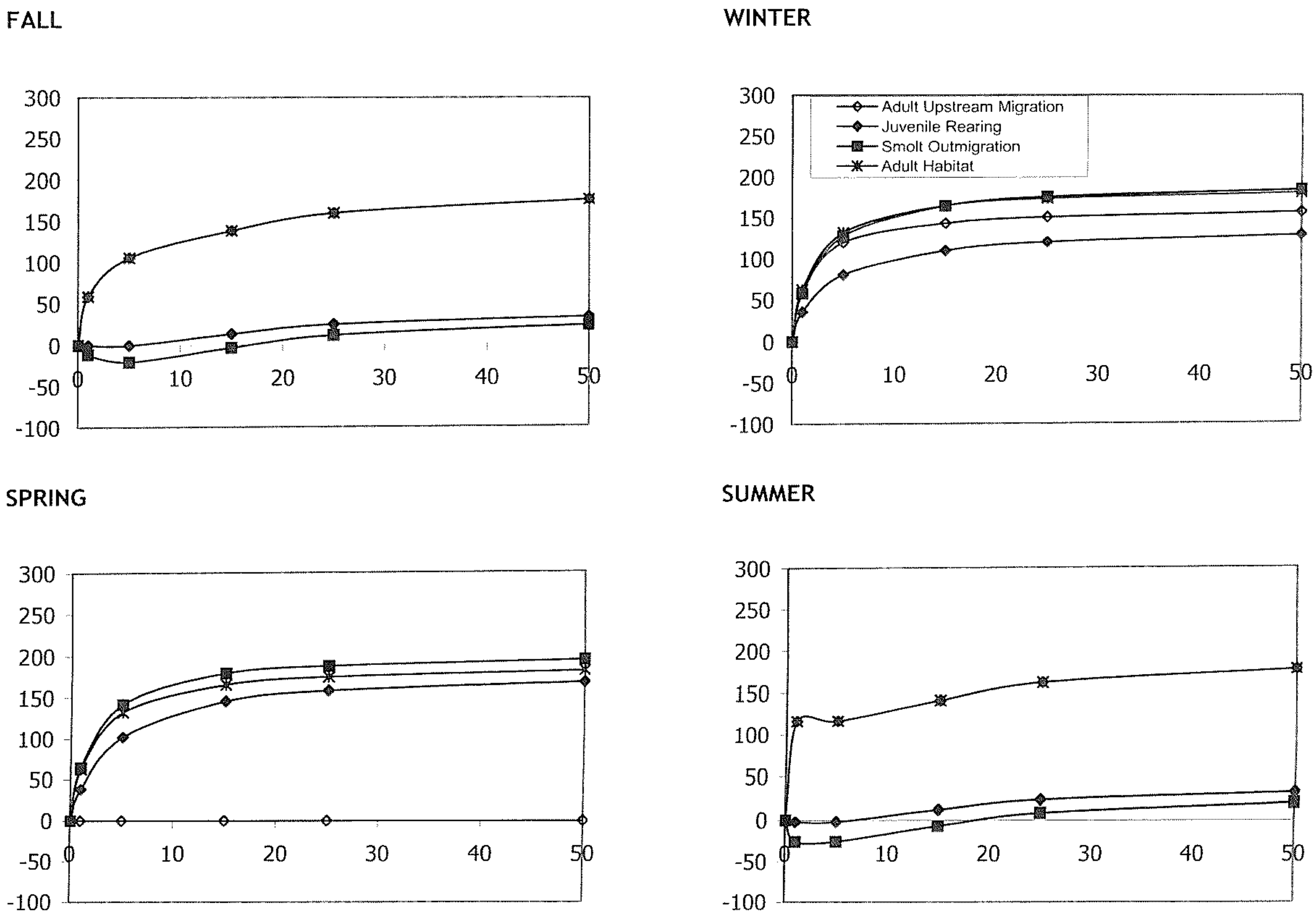

Figure 41. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 87.0L.

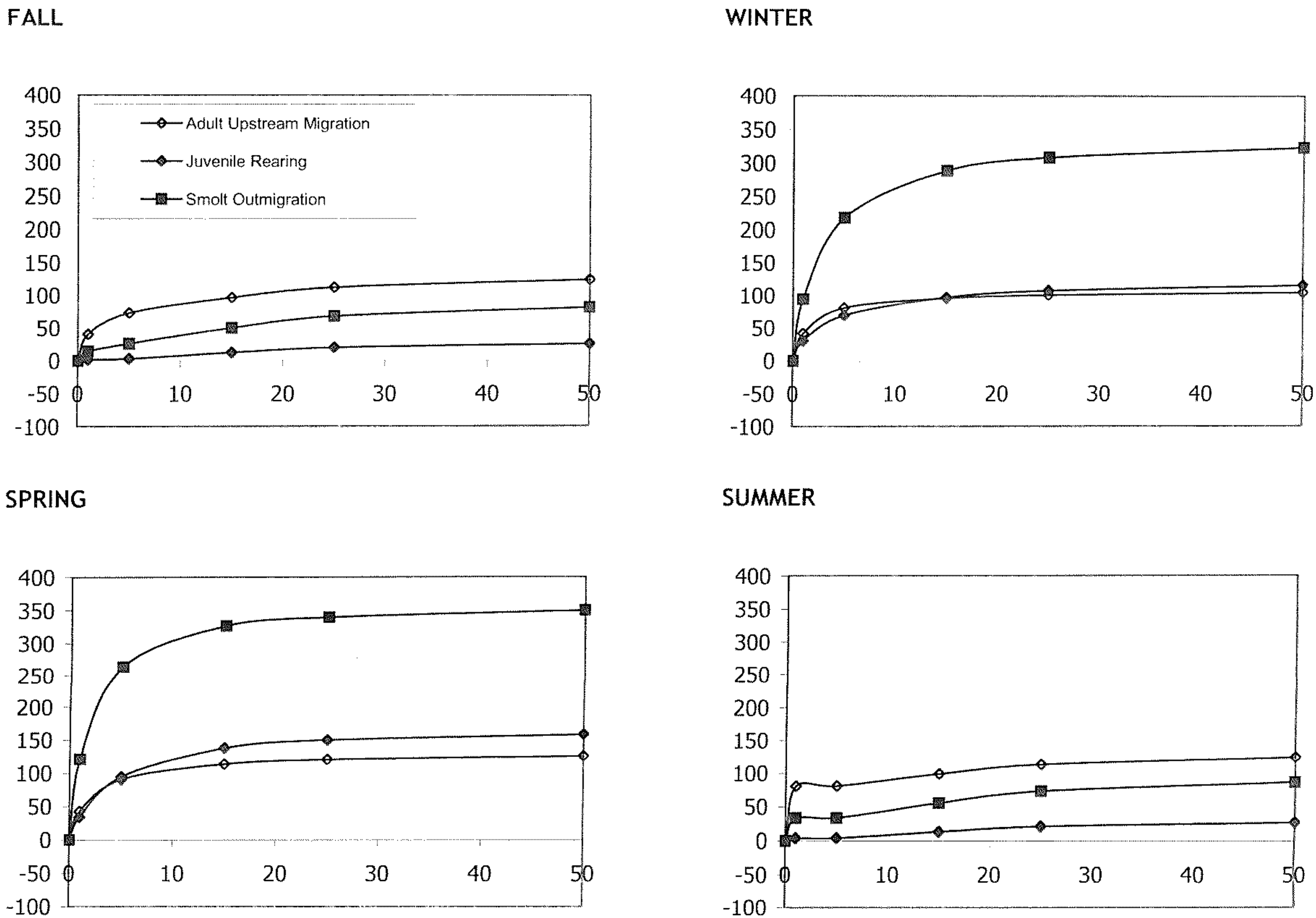

Figure 42. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 93.7L.

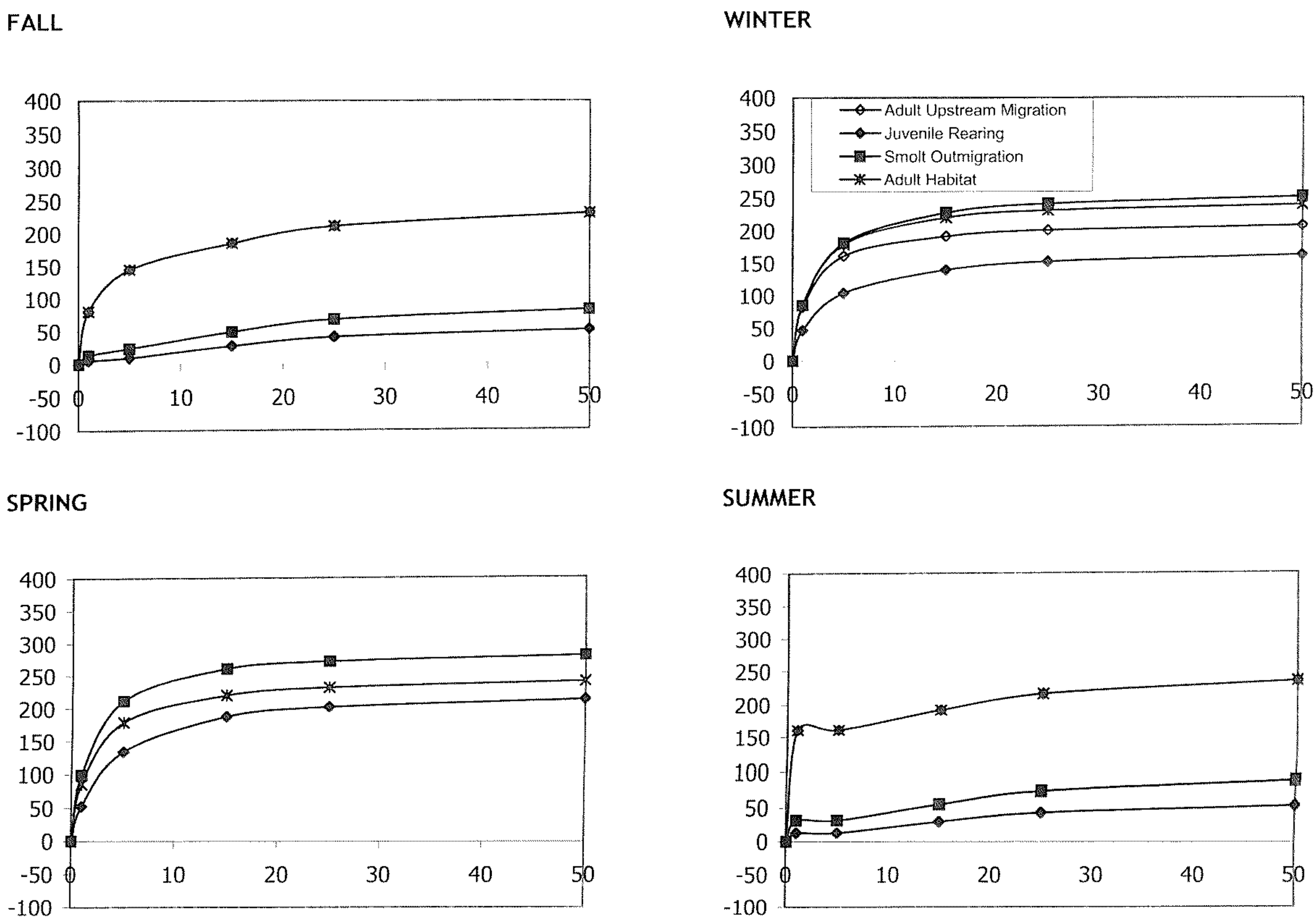

Figure 43. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 93.7L.

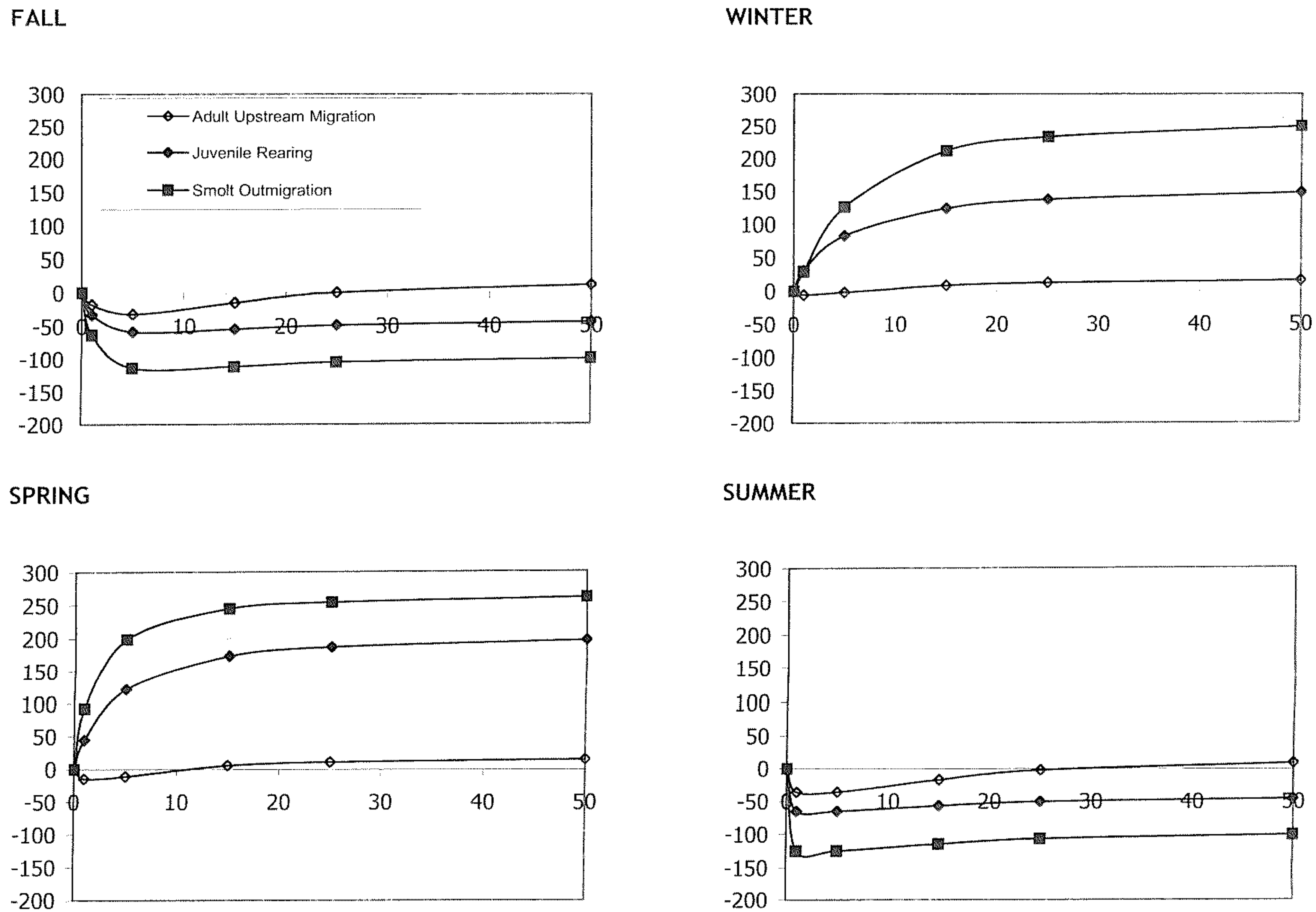

Figure 44. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 114.5R.

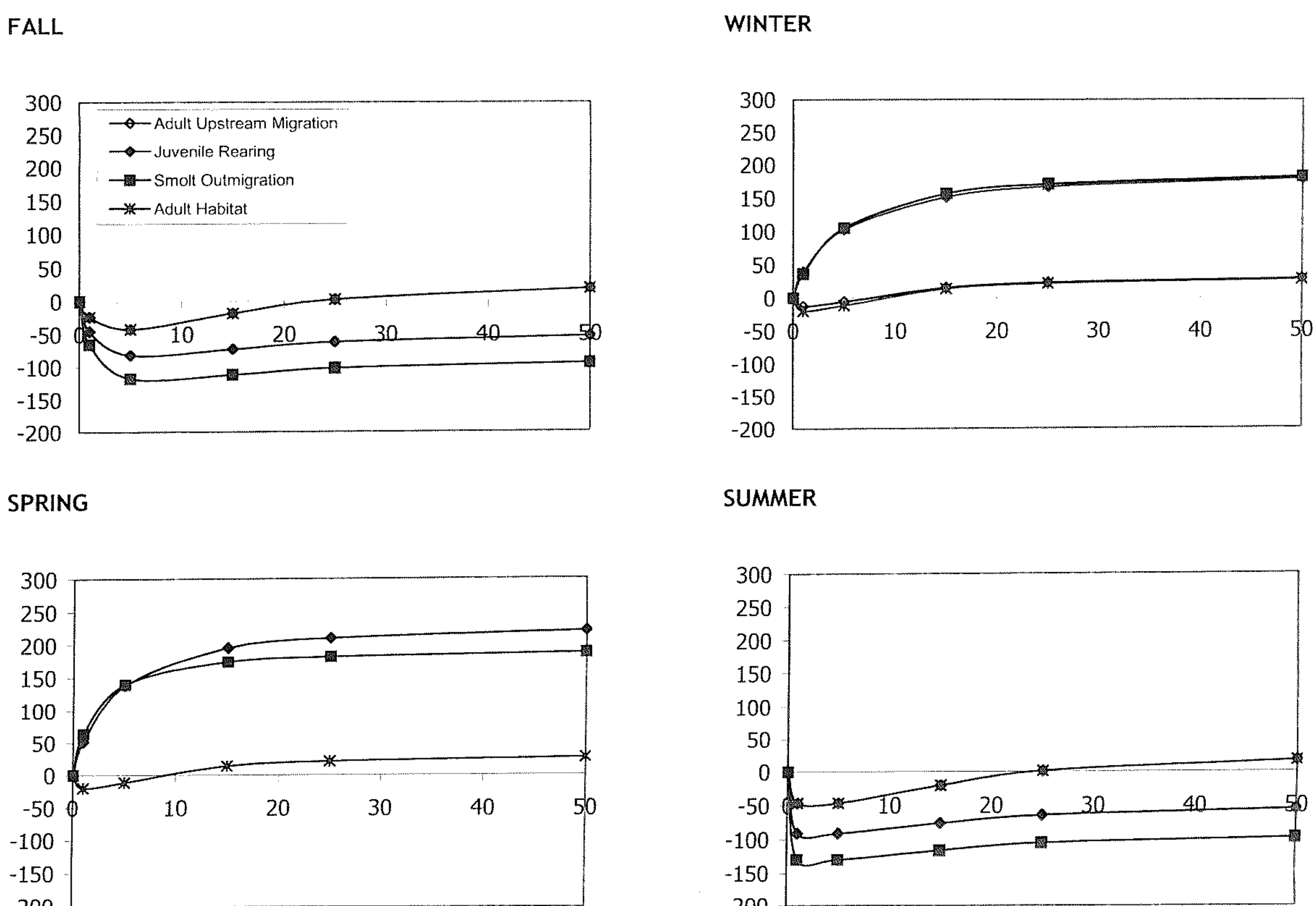

Figure 45. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 114.5R.

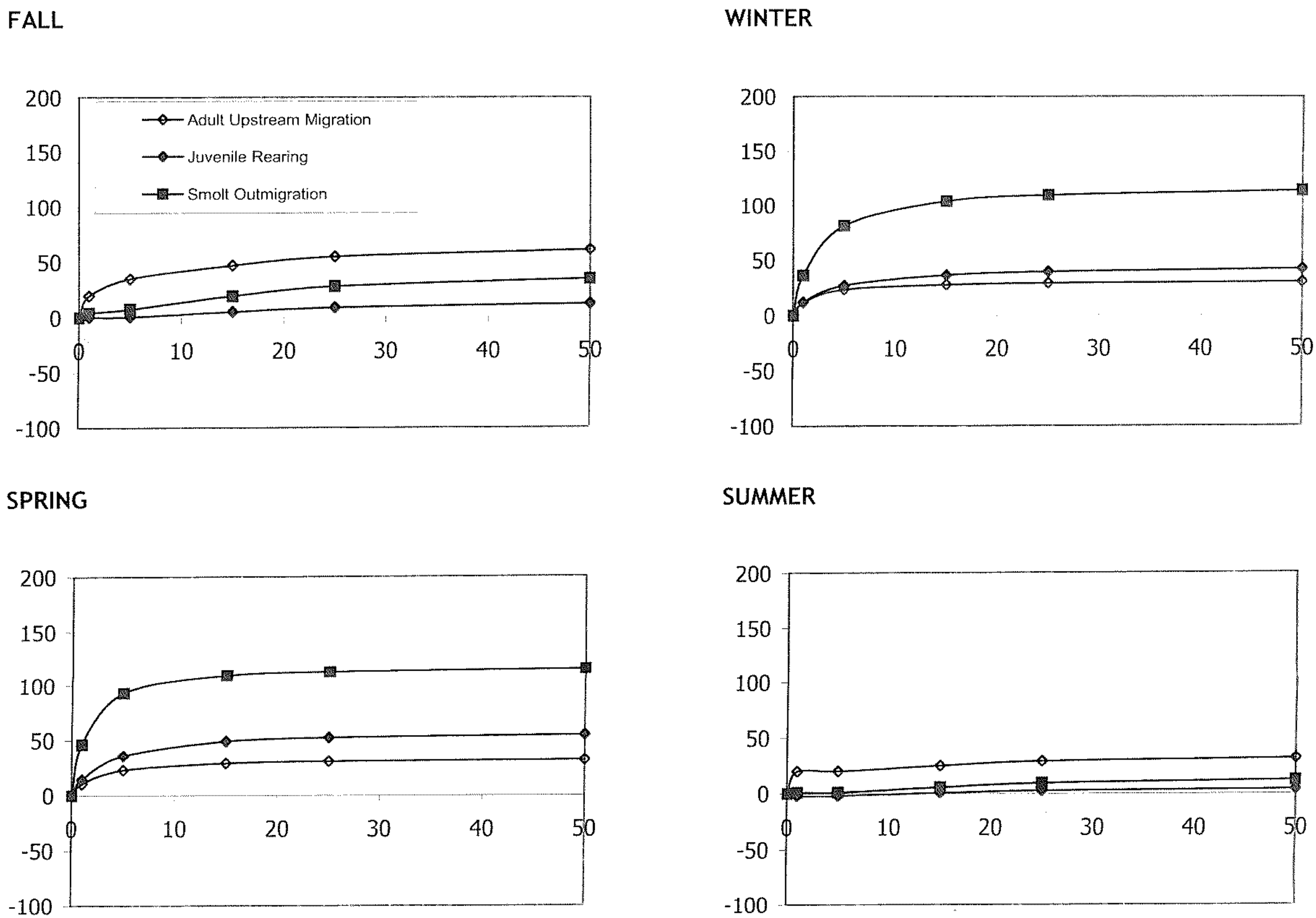

Figure 48. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 136.7R.

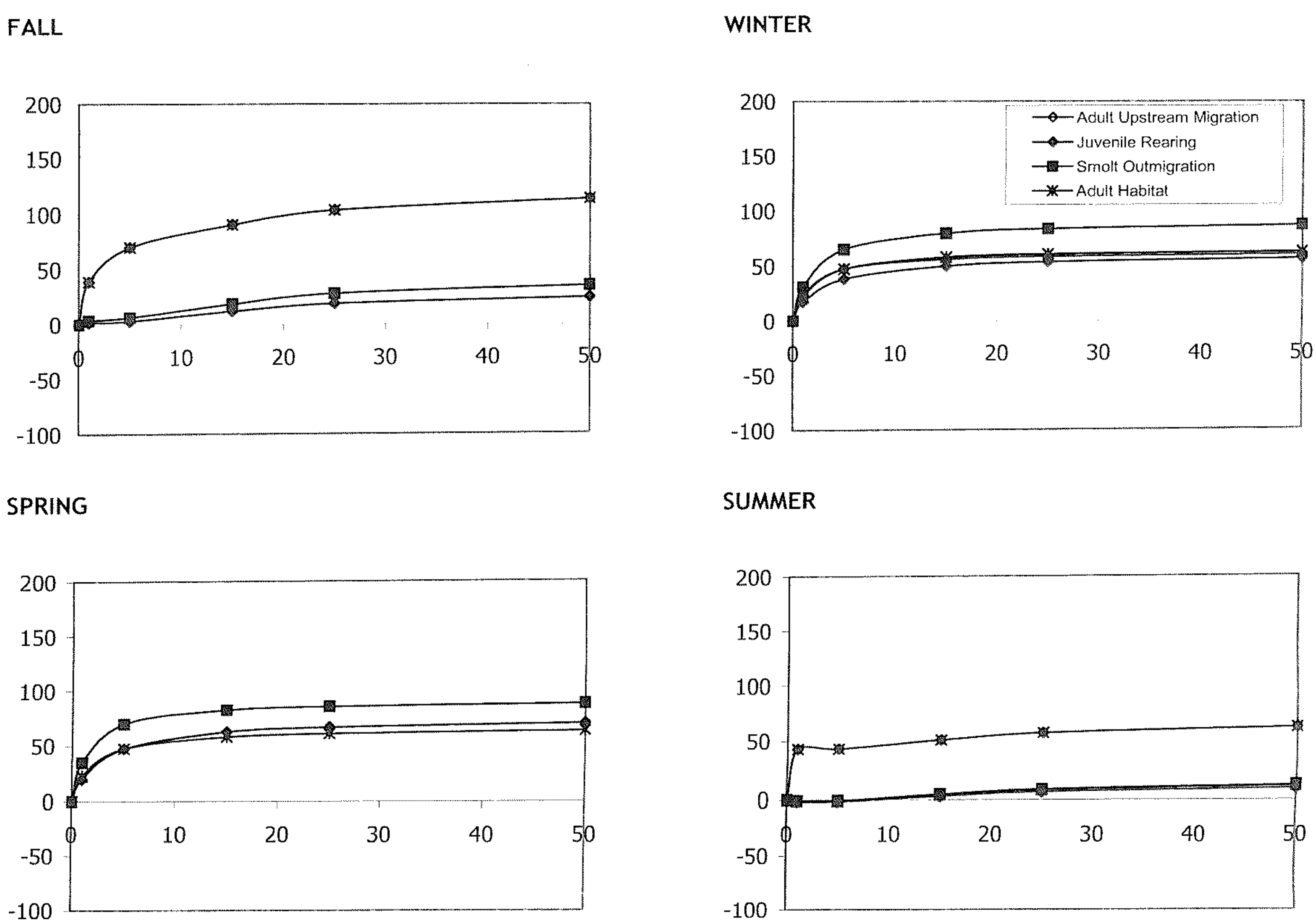

Figure 49. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 136.7R.

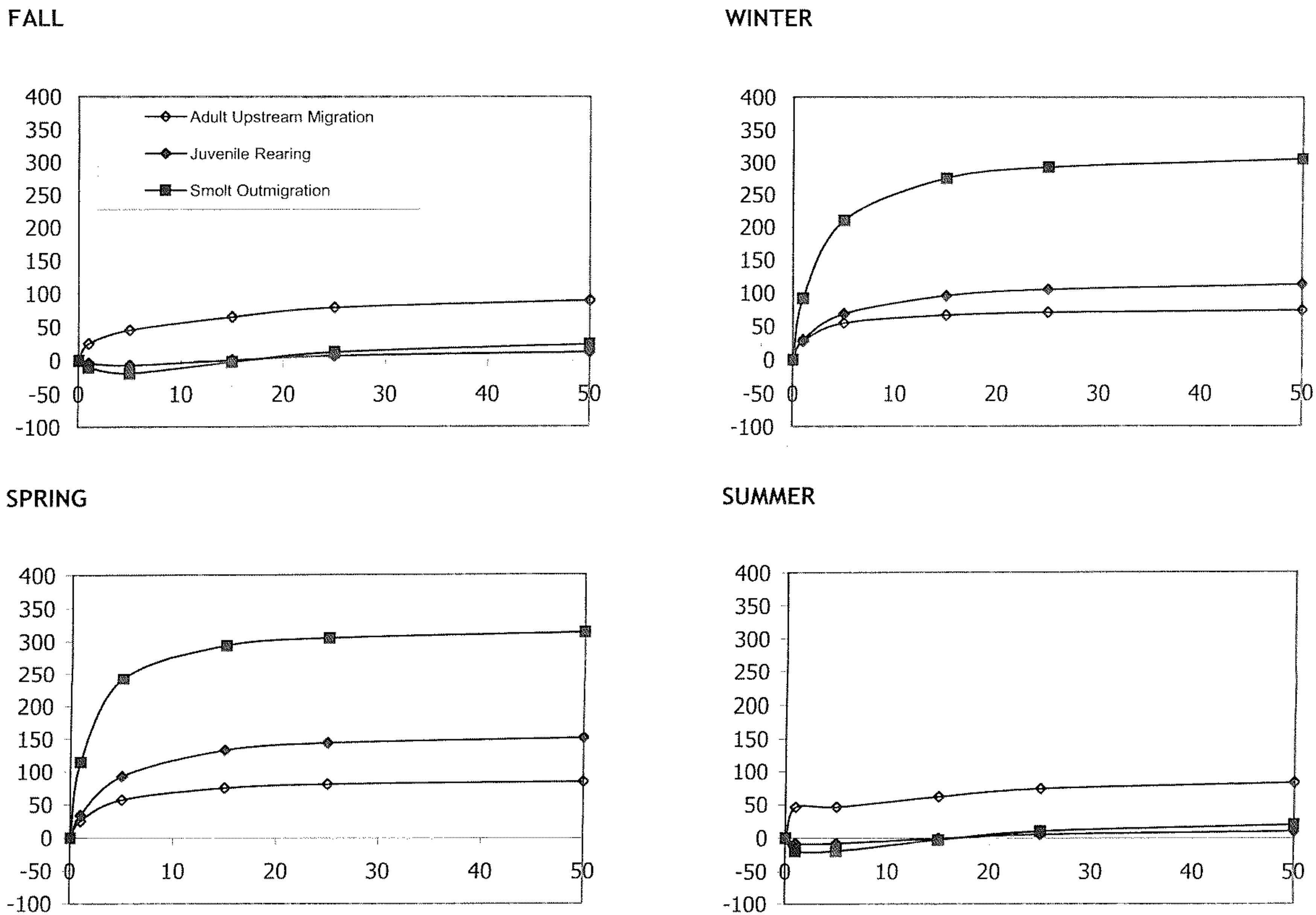

Figure 50. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 136.9R.

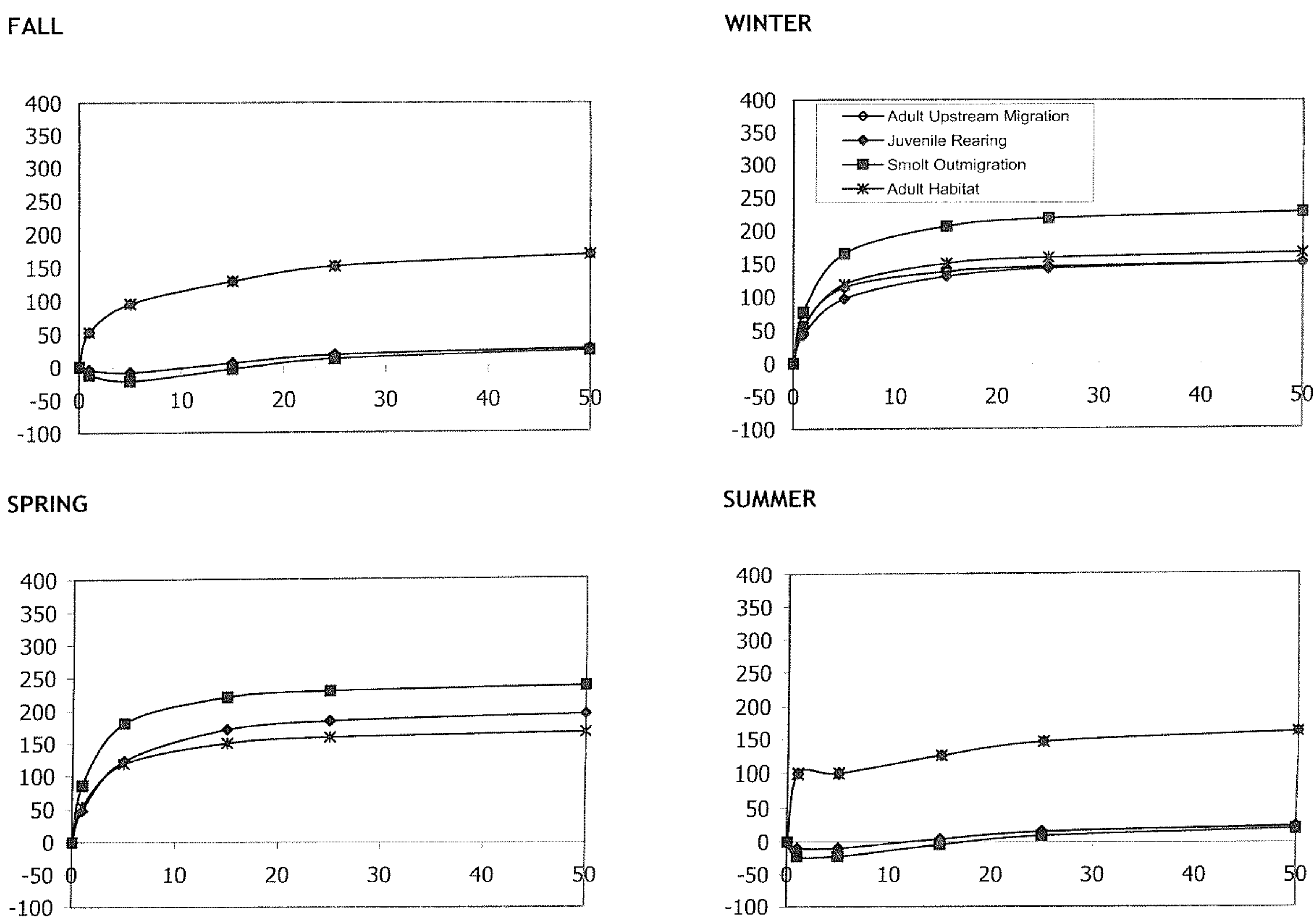

Figure 51. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sacramento River RM 136.9R.

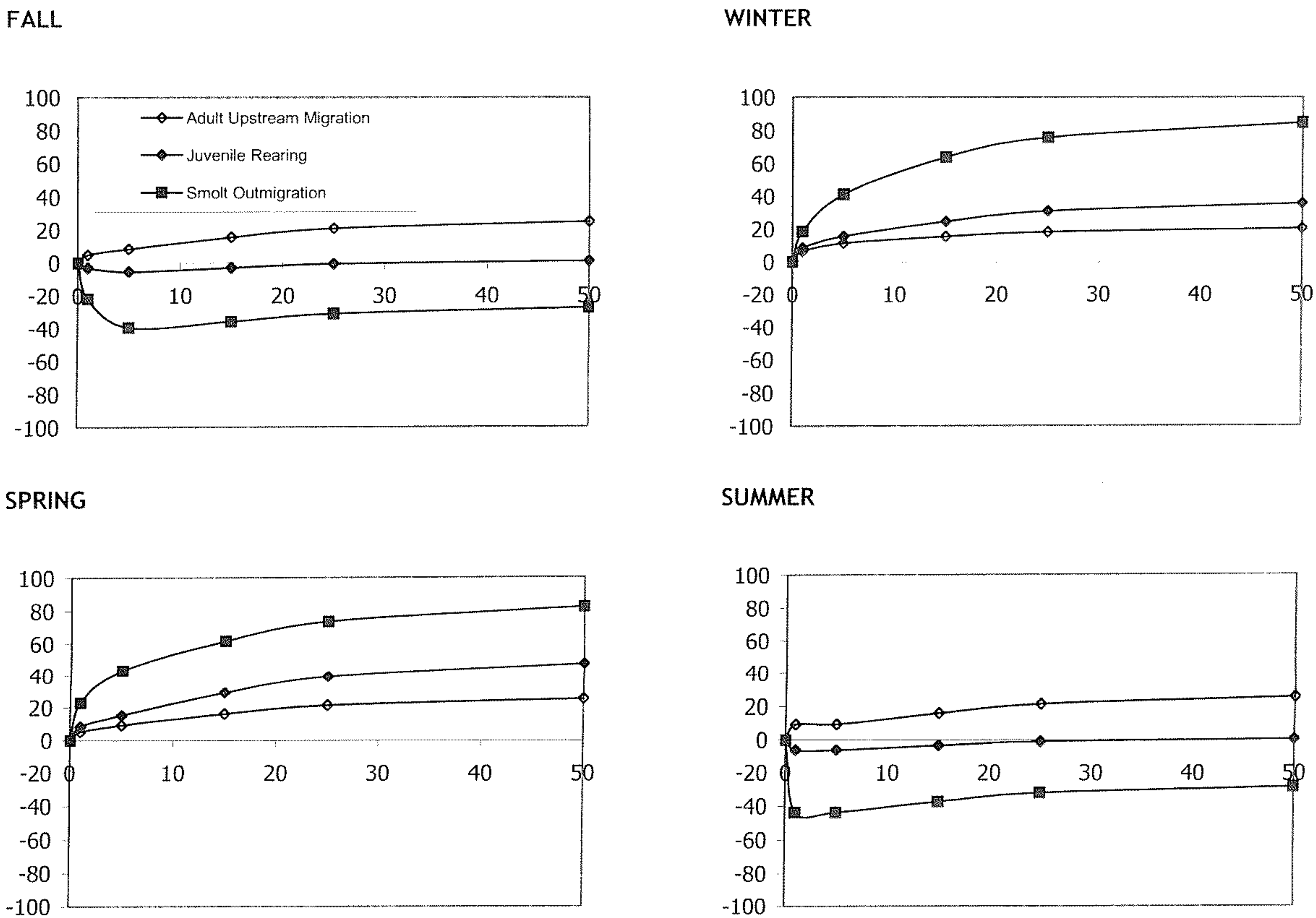

Figure 52. SAM results showing bankline weighted relative response (feet) for Chinook salmon (Winter-run shown) at site Sutter Bypass LM 0.4E.

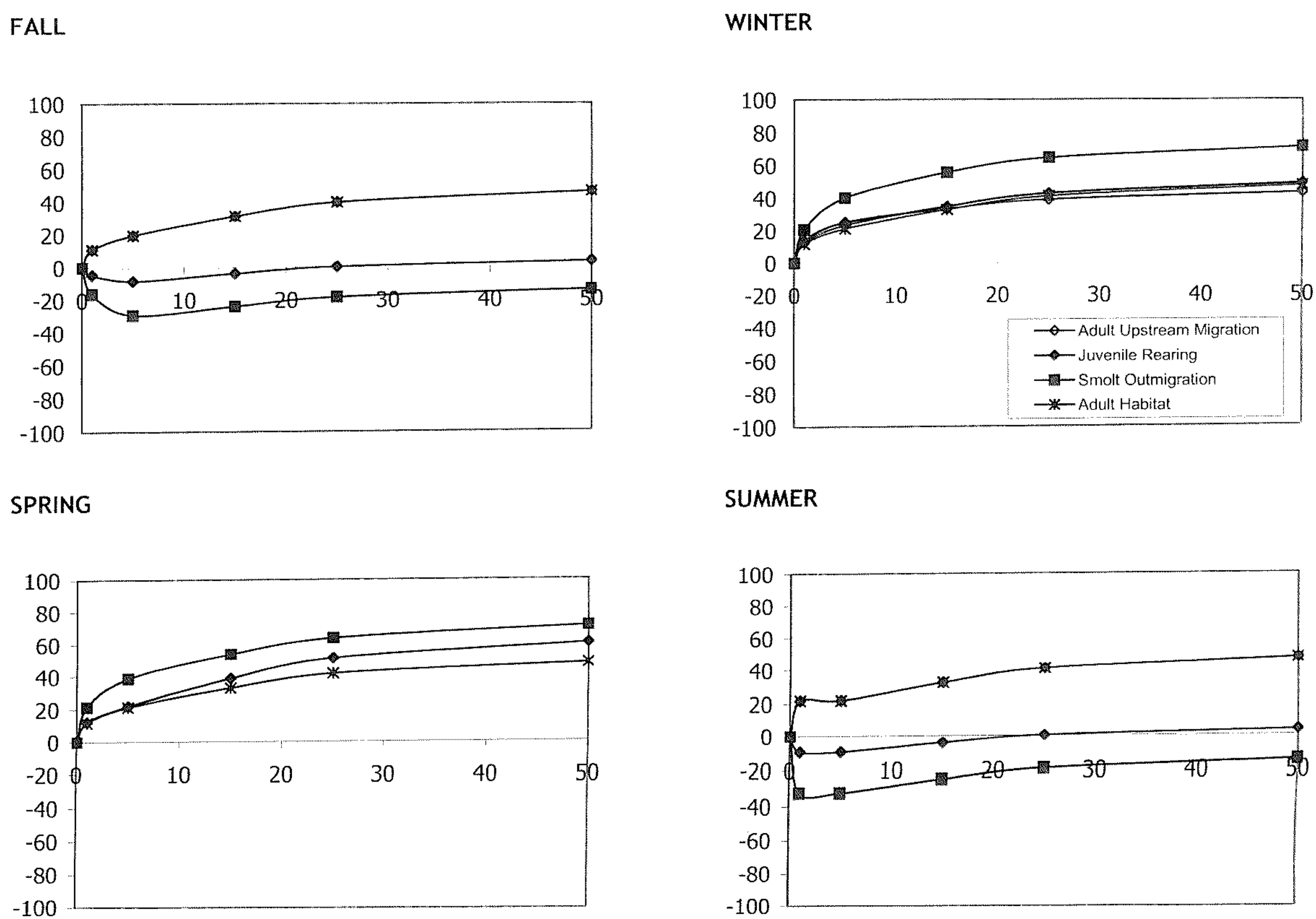

Figure 53. SAM results showing bankline weighted relative response (feet) for Central Valley steelhead at site Sutter Bypass LM 0.4E.

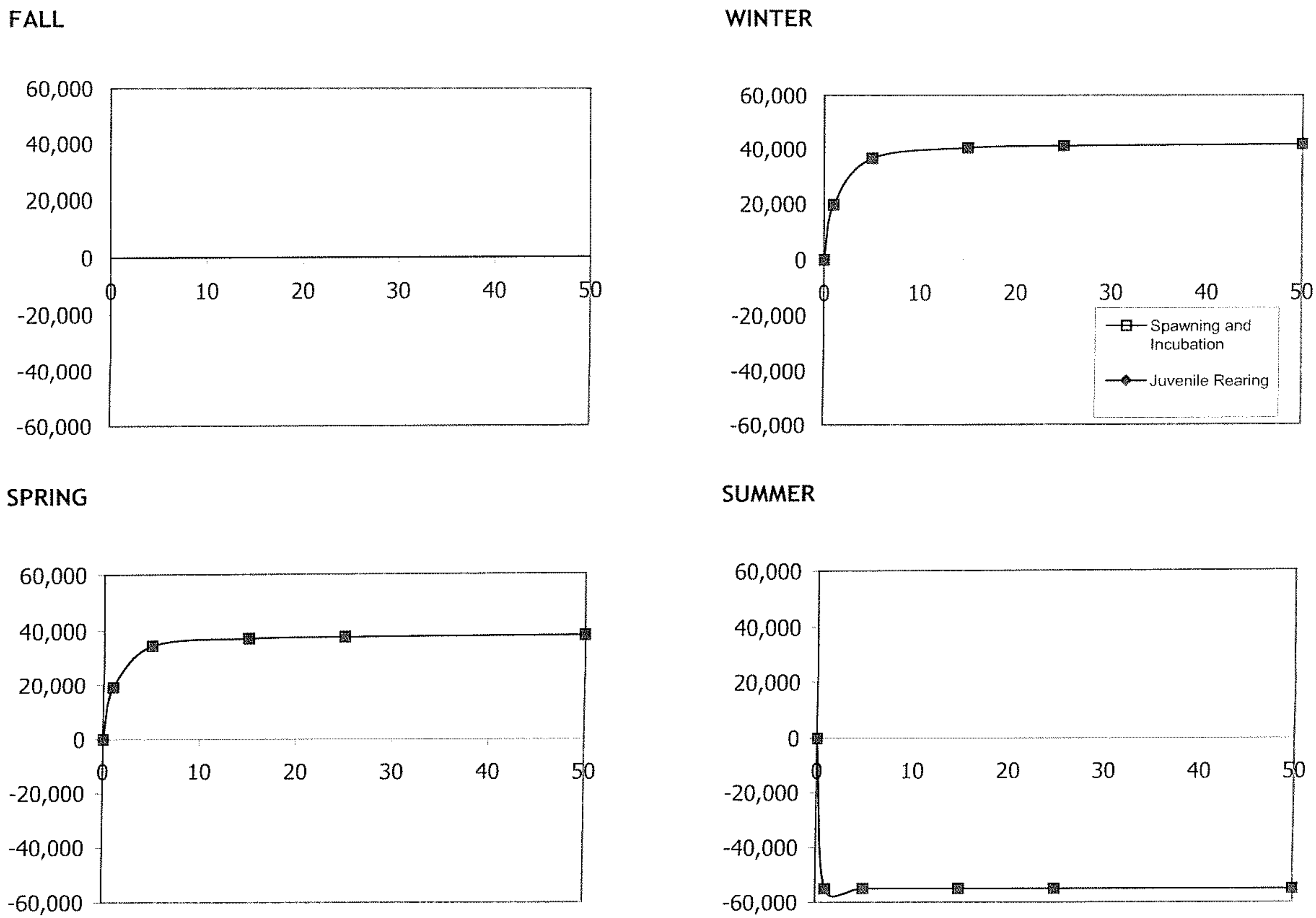

Figure 64. SAM results showing wetted-area weighted relative response (square feet) for delta smelt at site Sacramento River RM 26.0L.

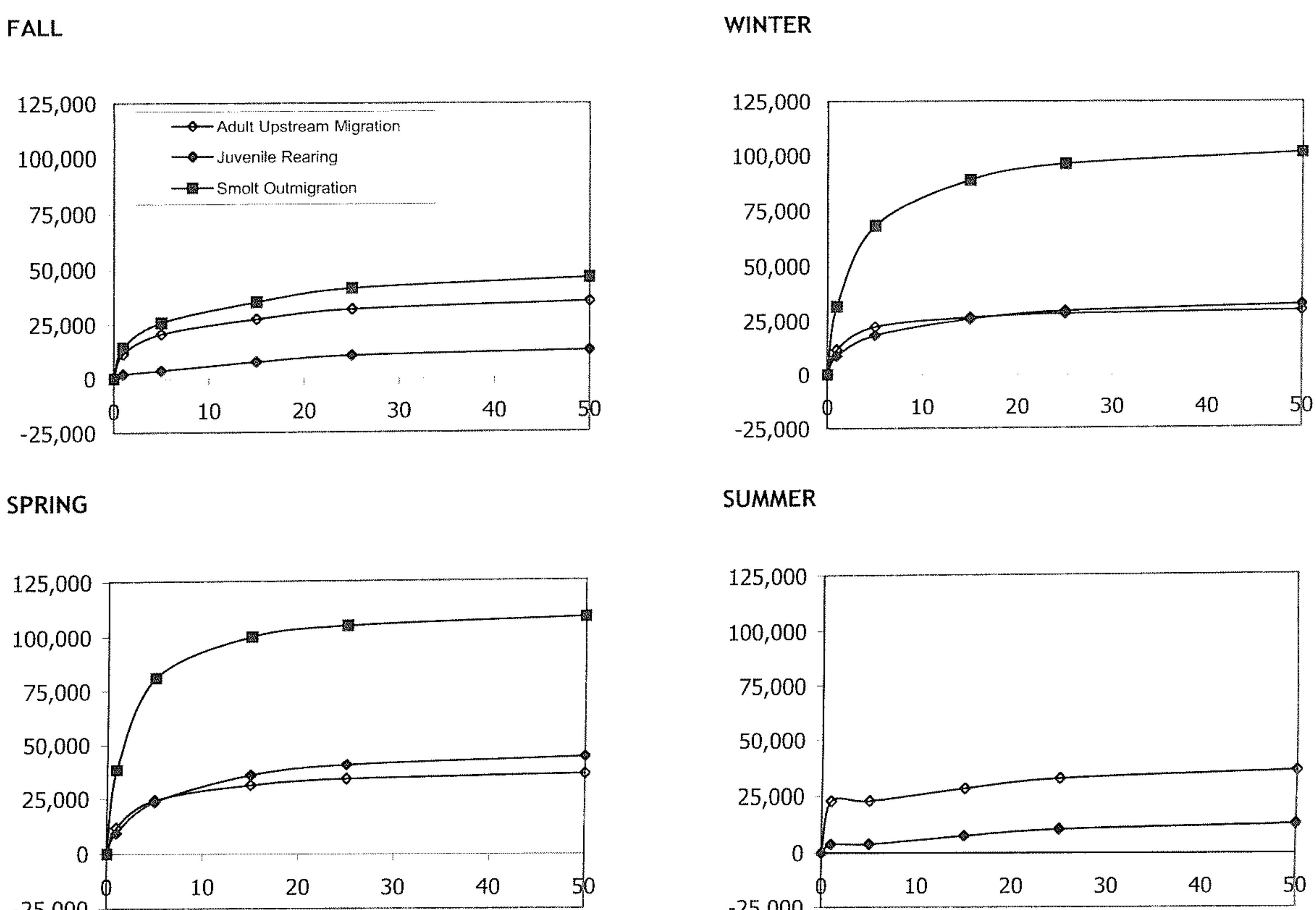

Figure 65. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 35.4L.

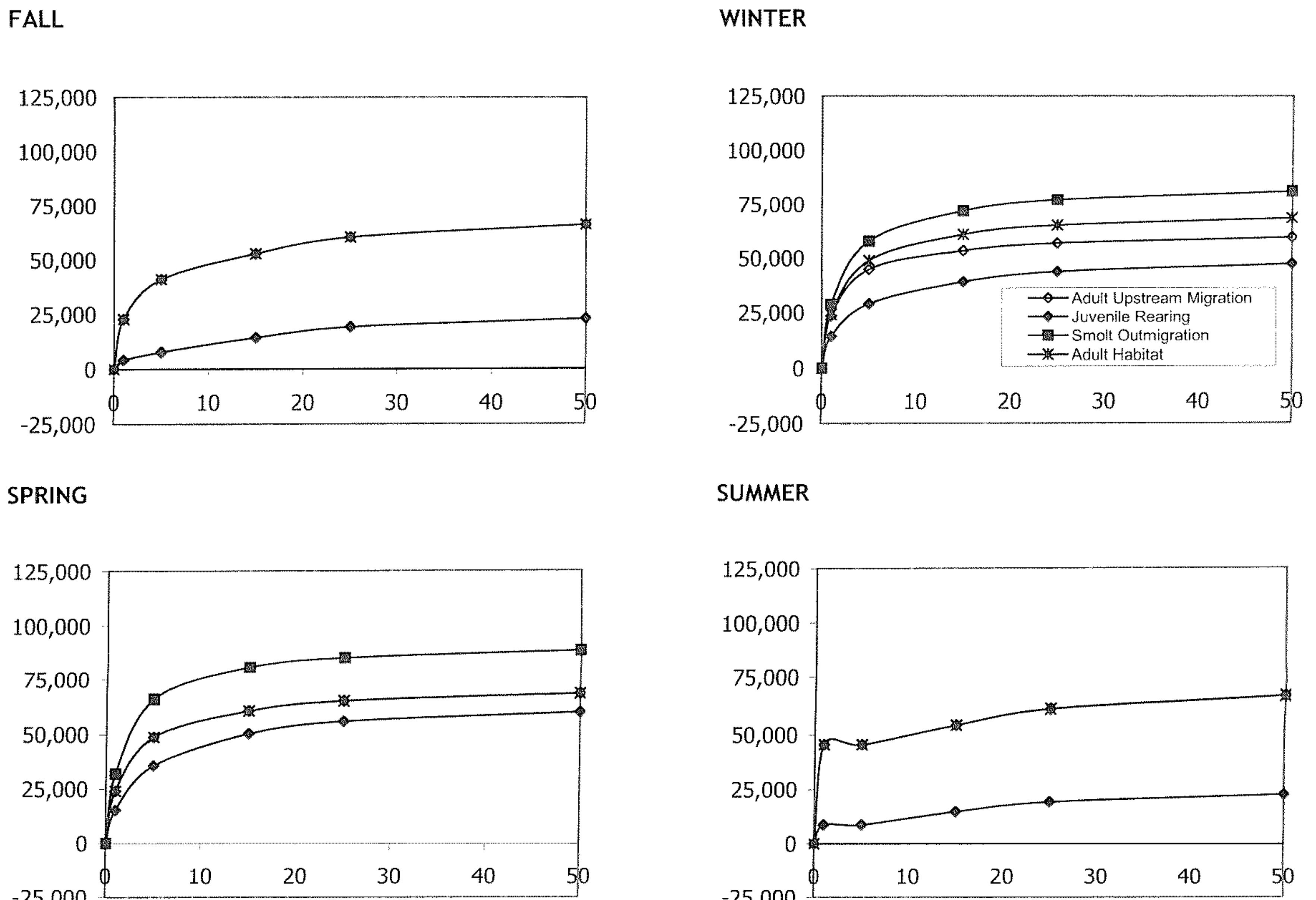

Figure 66. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 35.4L.

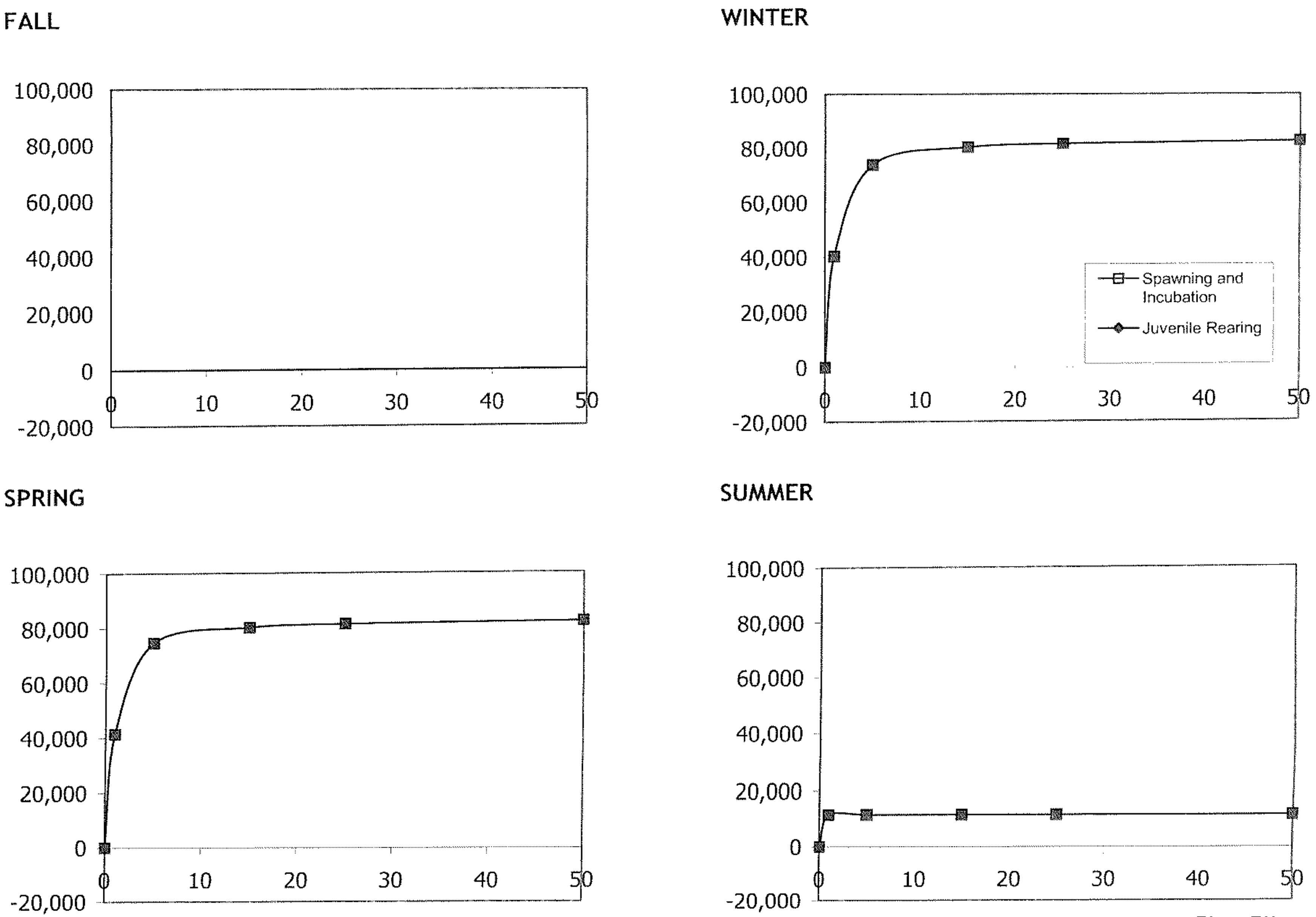

Figure 67. SAM results showing wetted-area weighted relative response (square feet) for delta smelt at site Sacramento River RM 35.4L.

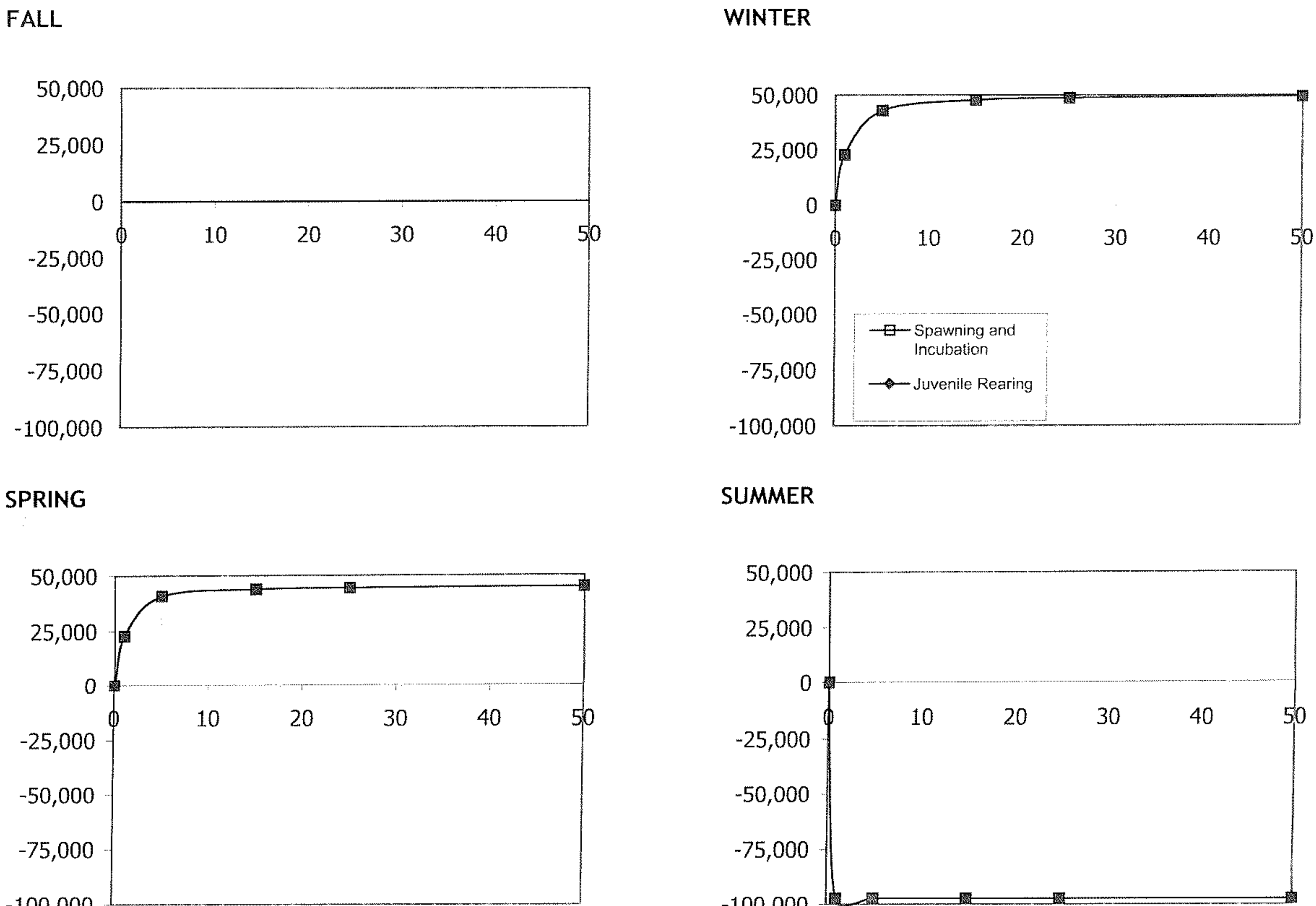

Figure 70. SAM results showing wetted-area weighted relative response (square feet) for delta smelt at site Sacramento River RM 41.9R.

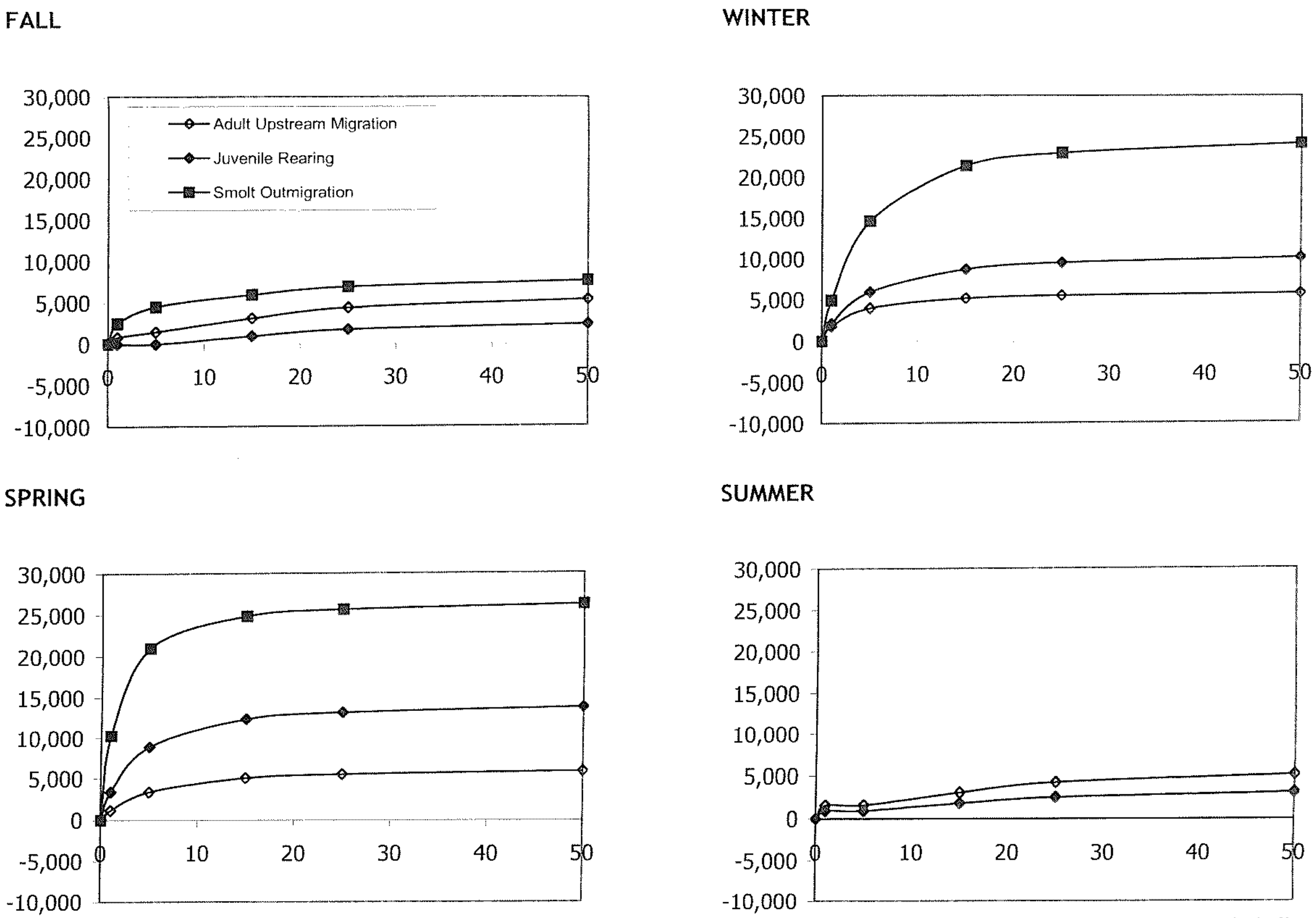

Figure 71. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Lower American River RM 10.0L.

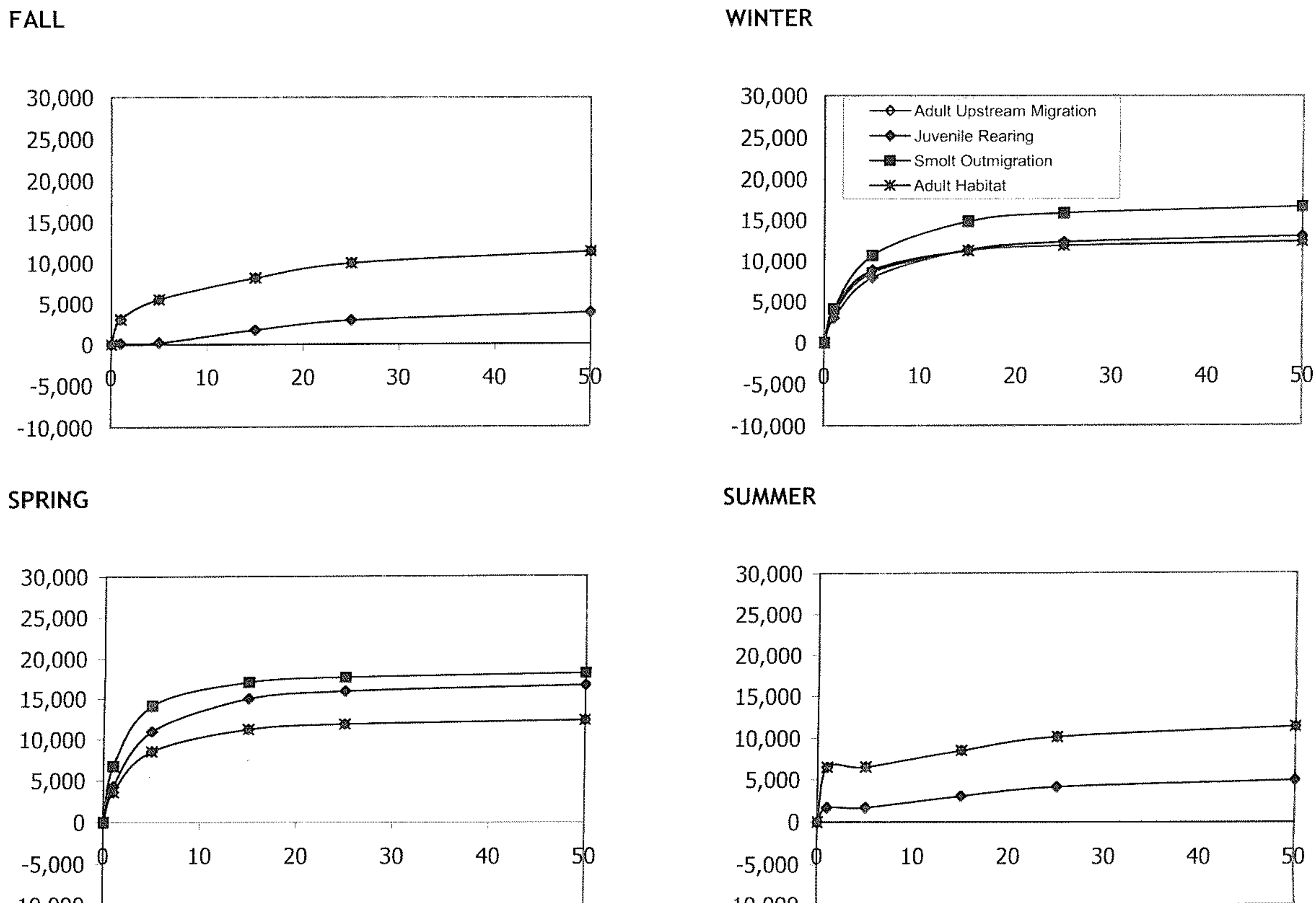

Figure 72. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Lower American River RM 10.0L.

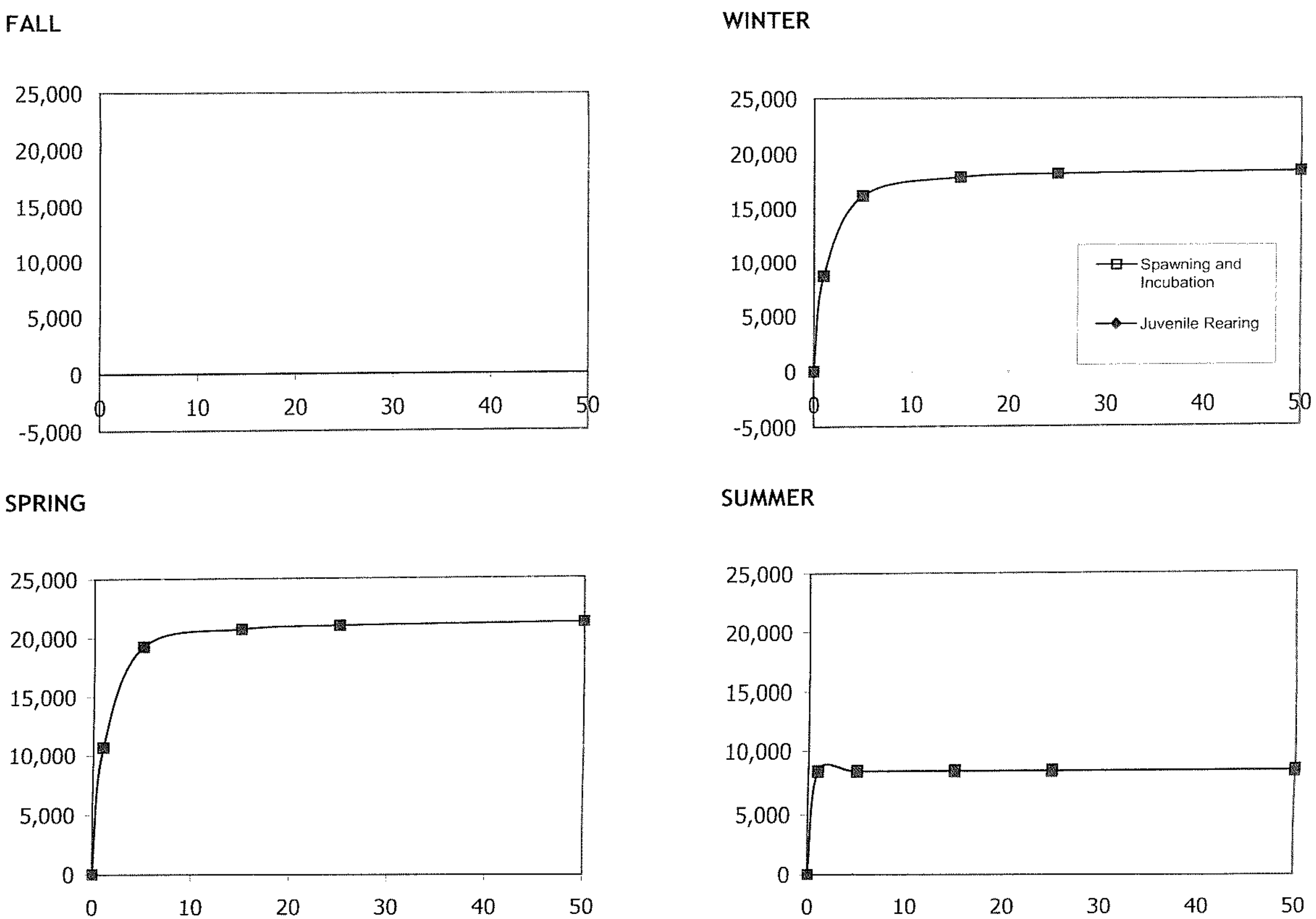

Figure 73. SAM results showing wetted-area weighted relative response (square feet) for delta smelt at site Lower American River RM 10.0L.

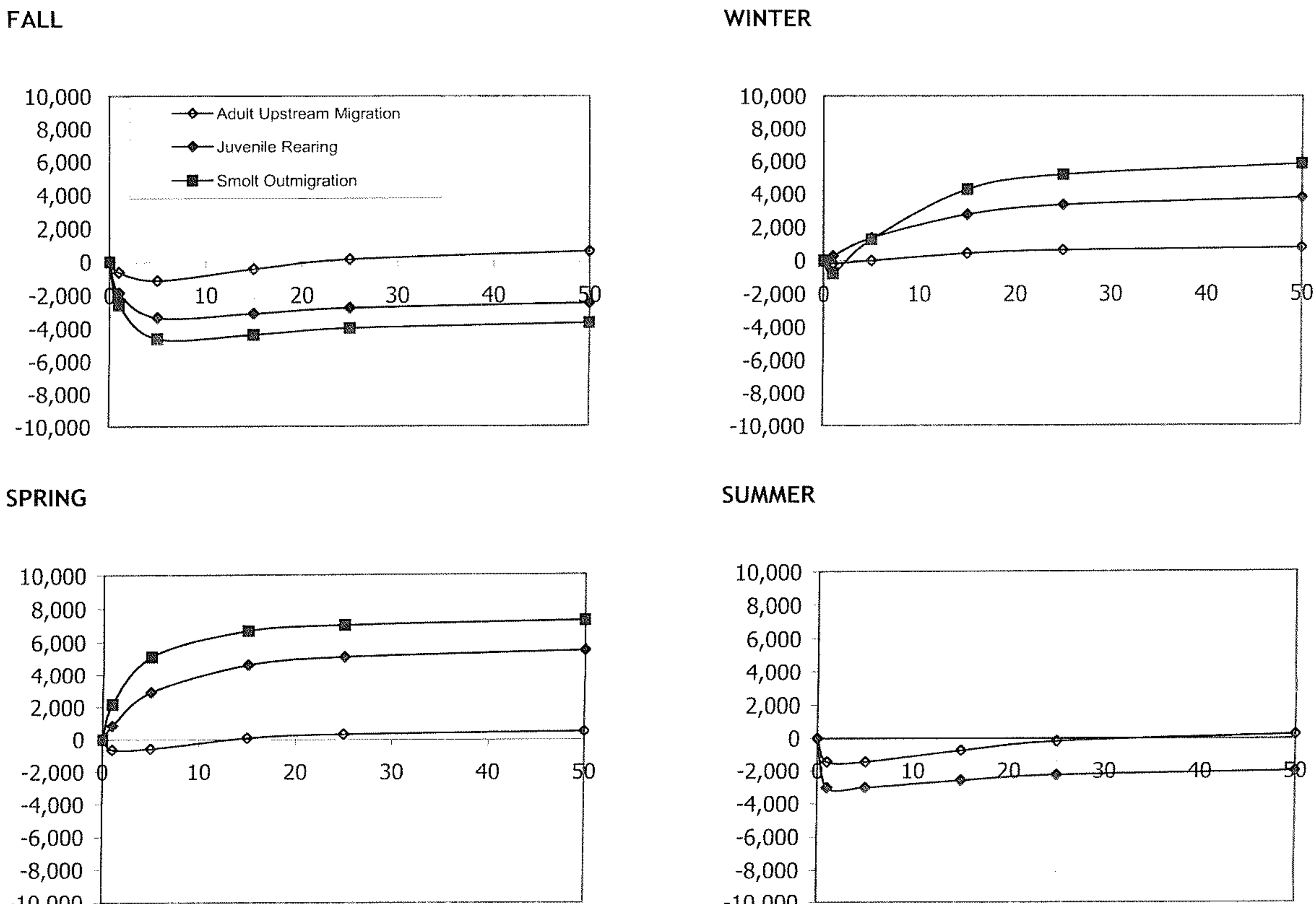

Figure 74. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Lower American River RM 10.6L.

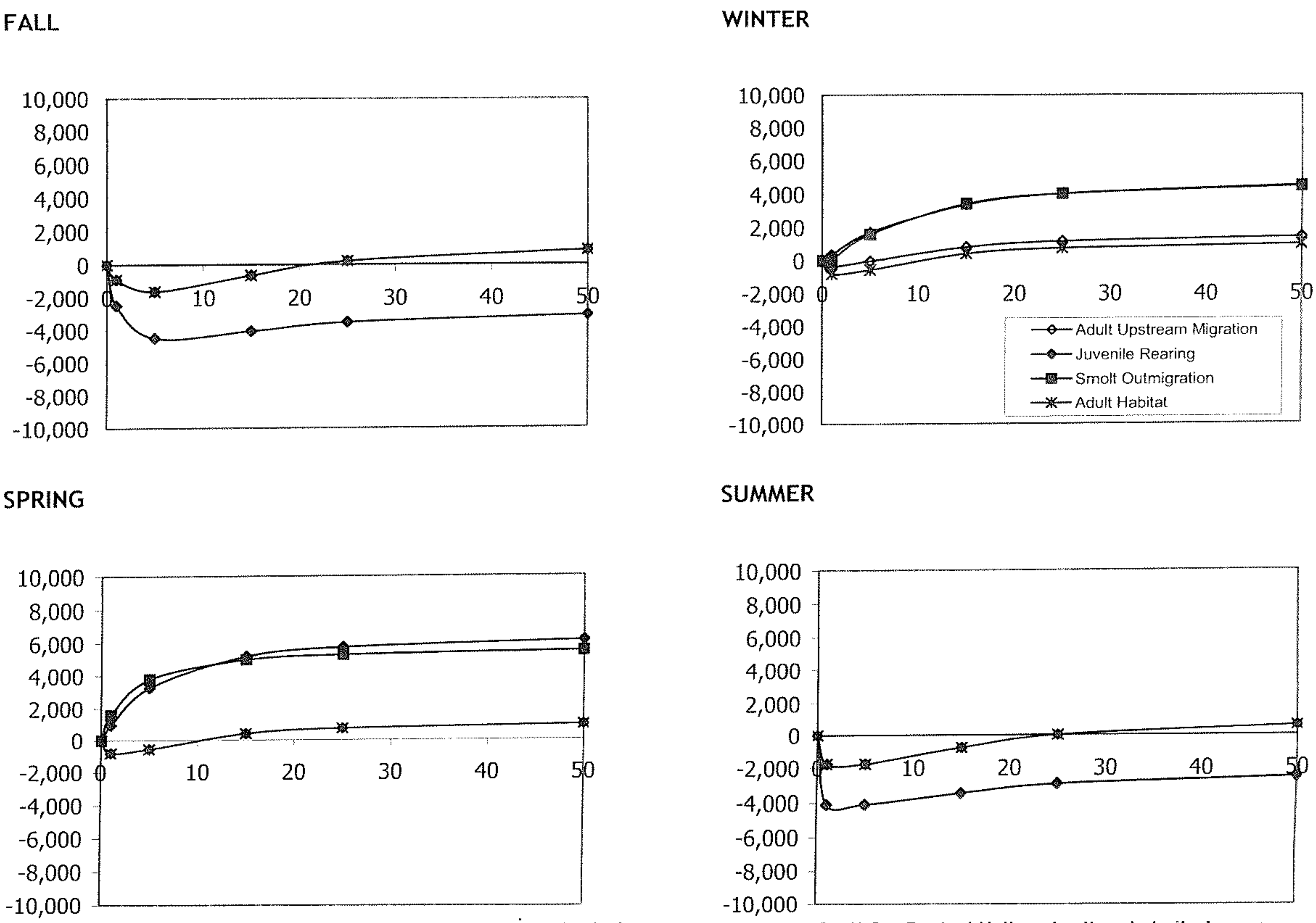

Figure 75. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Lower American River RM 10.6L.

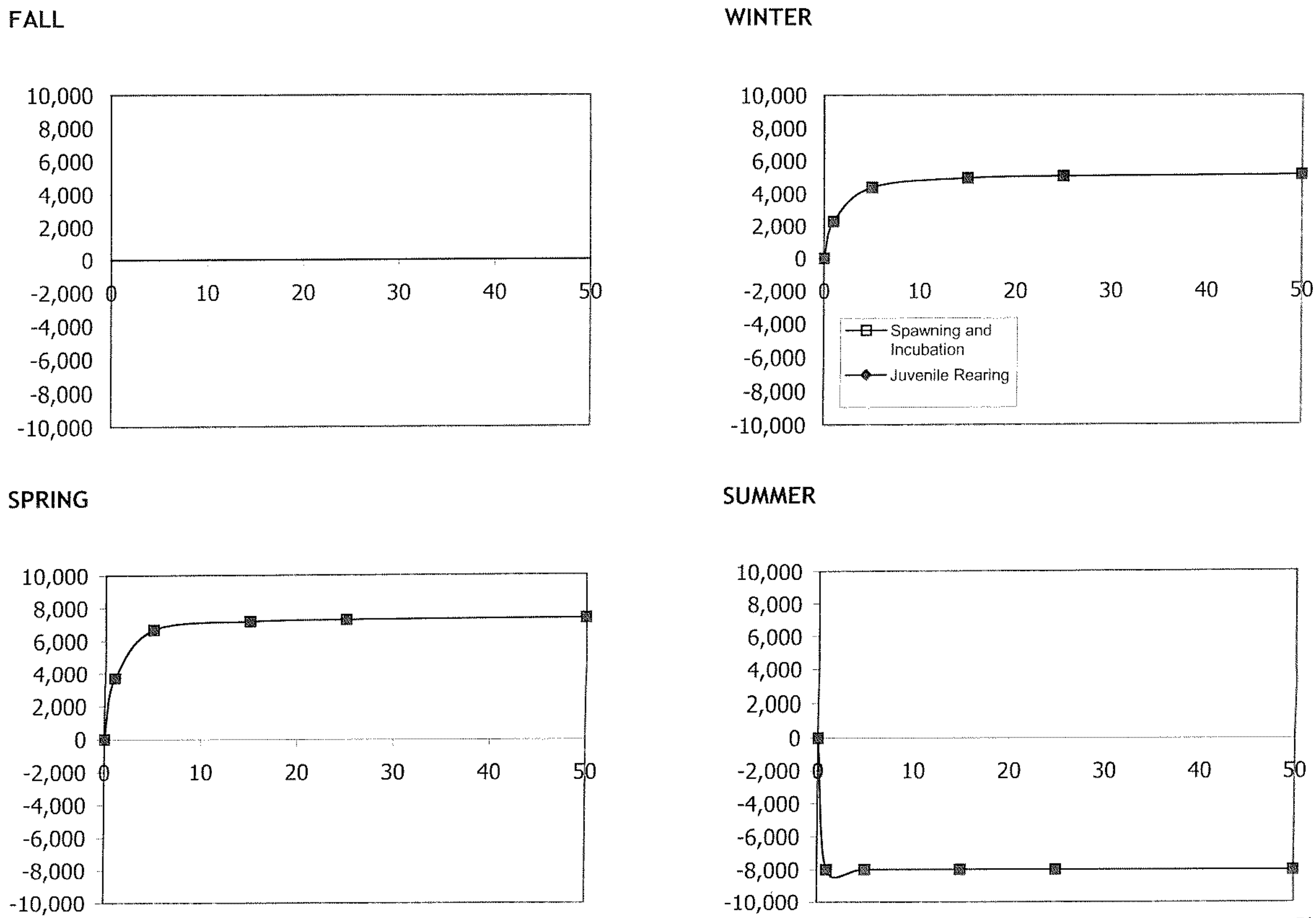

Figure 76. SAM results showing wetted-area weighted relative response (square feet) for delta smelt at site Lower American River RM 10.6L.

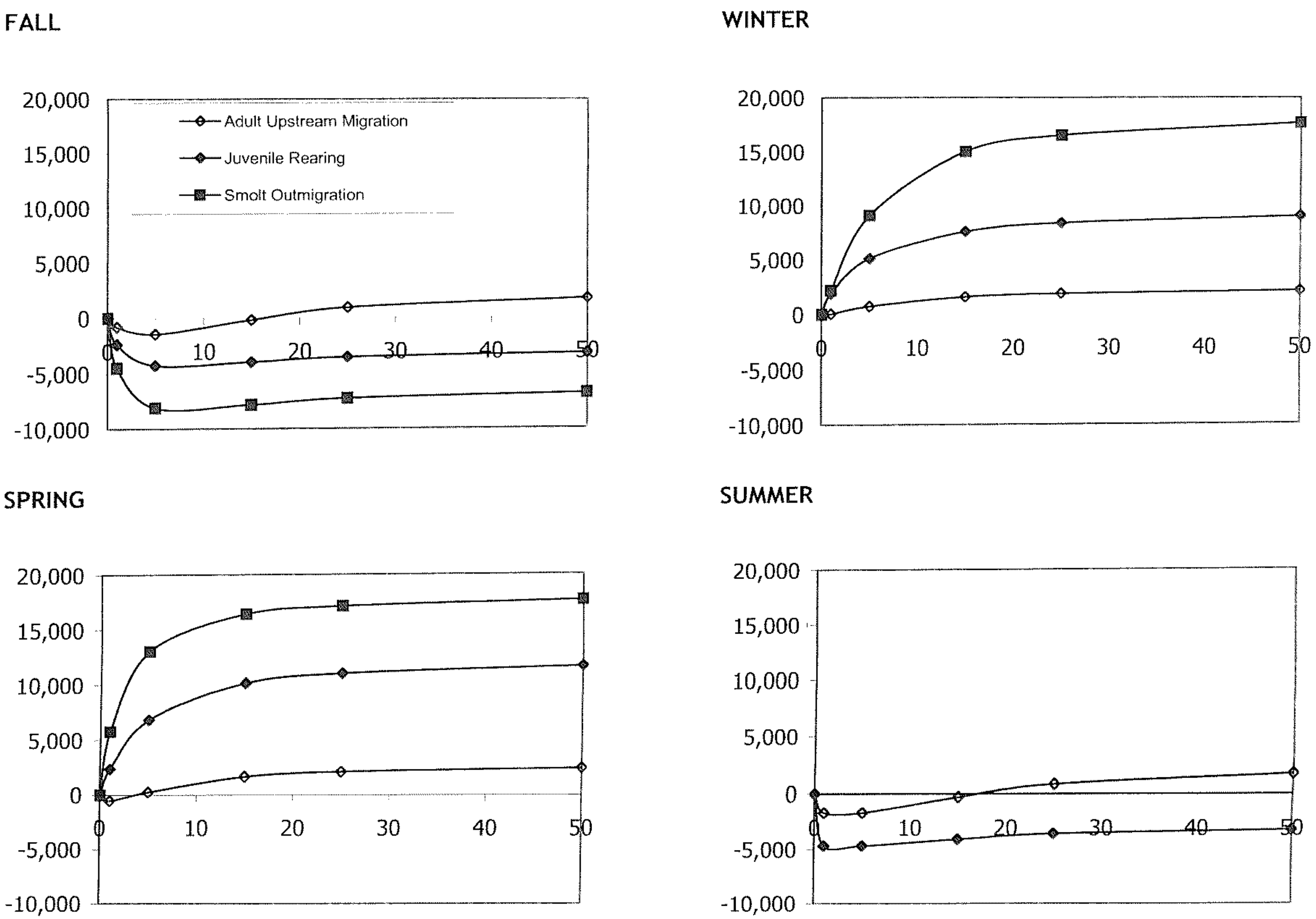

Figure 77. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 71.3R.

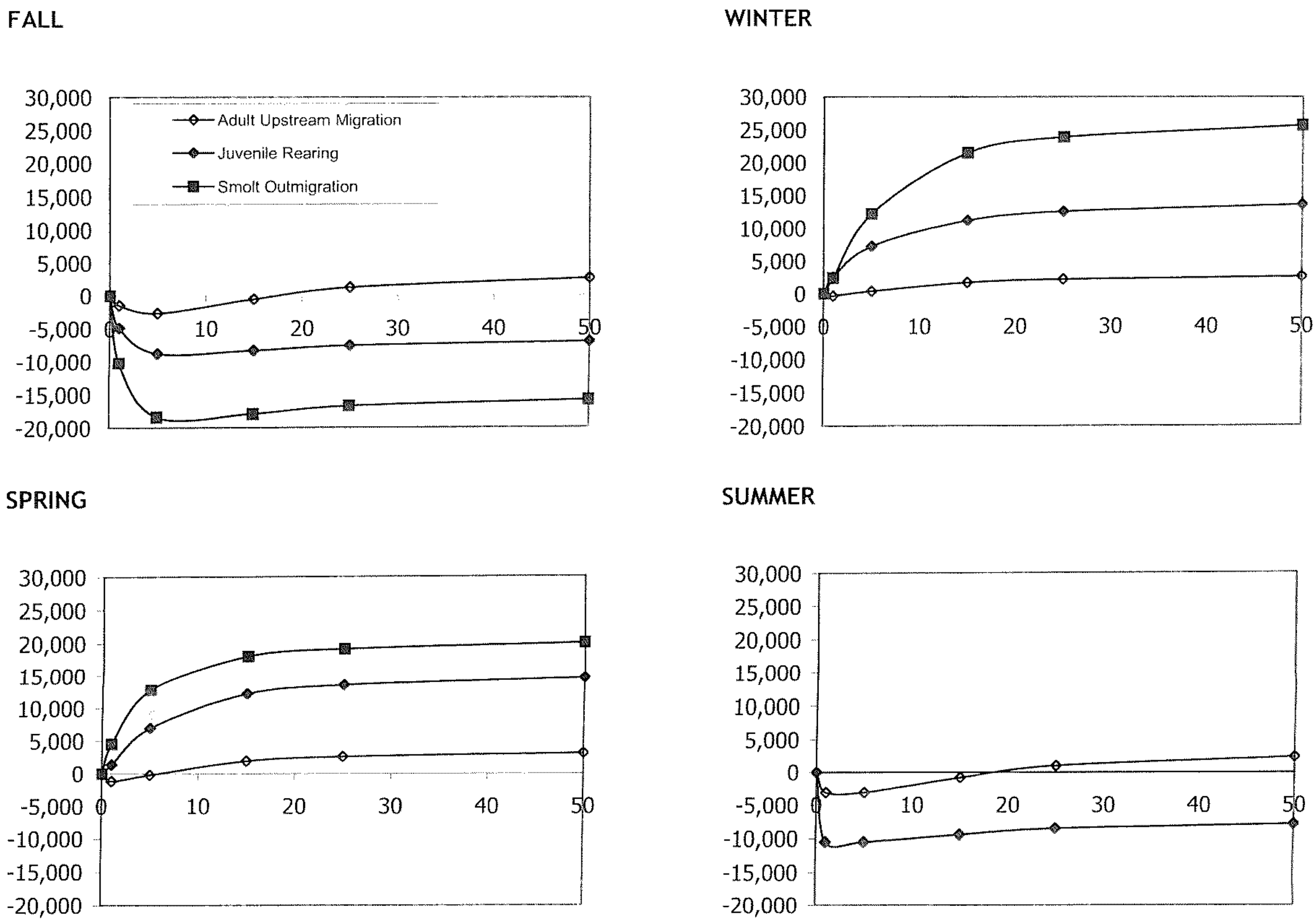

Figure 80. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 73.5L.

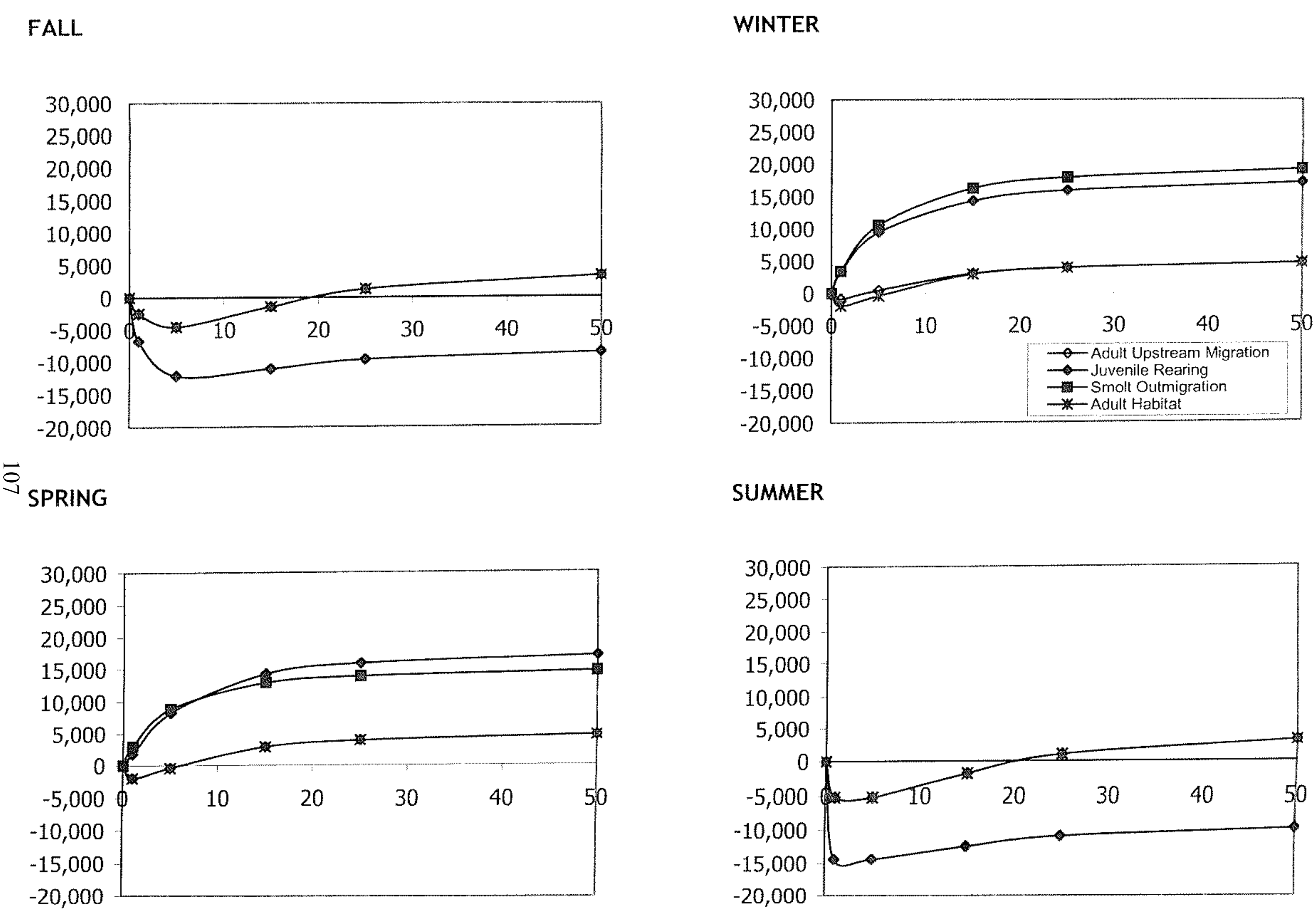

Figure 81. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 73.5L.

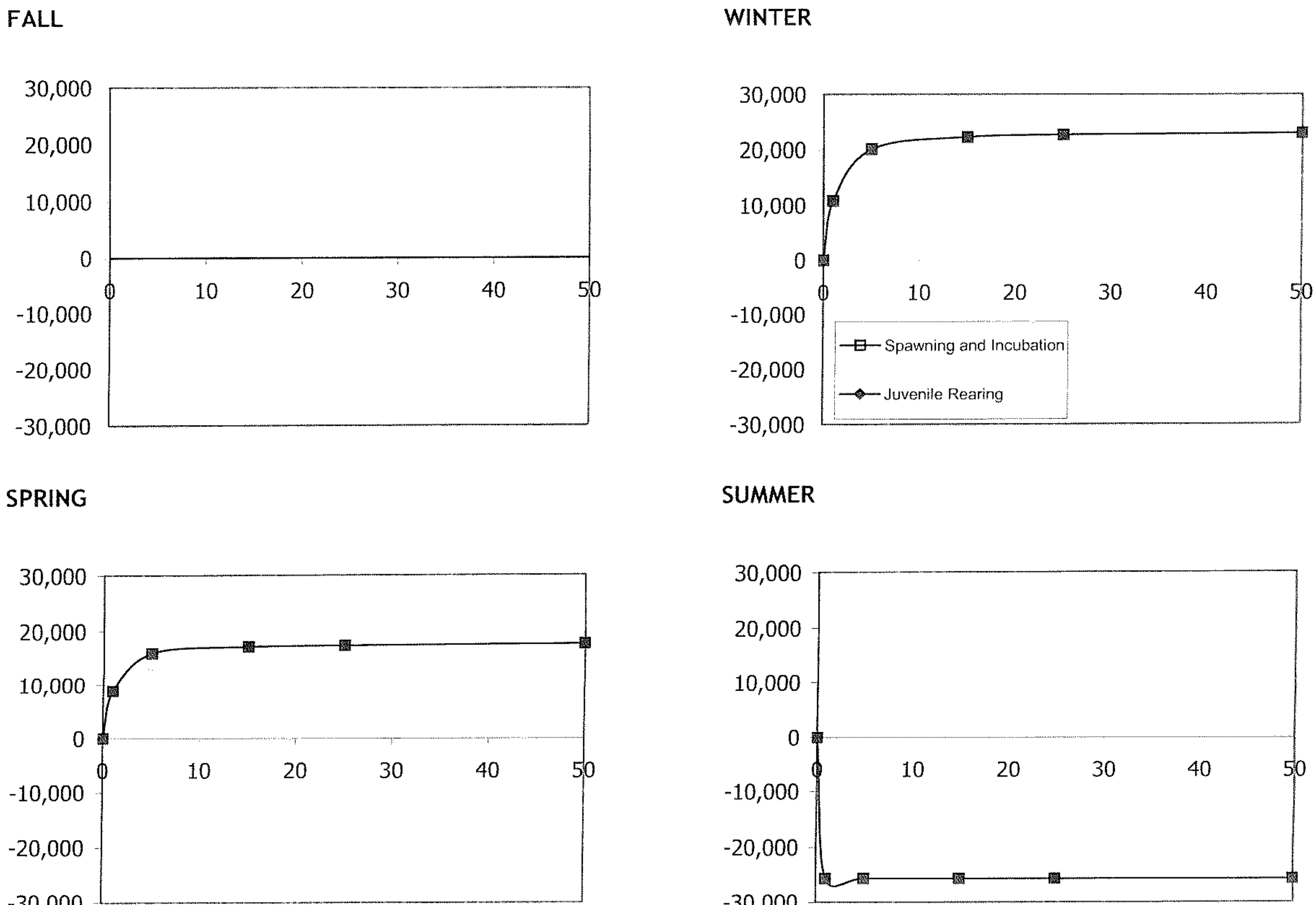

Figure 82. SAM results showing wetted-area weighted relative response (square feet) for delta smelt at site Sacramento River RM 73.5L.

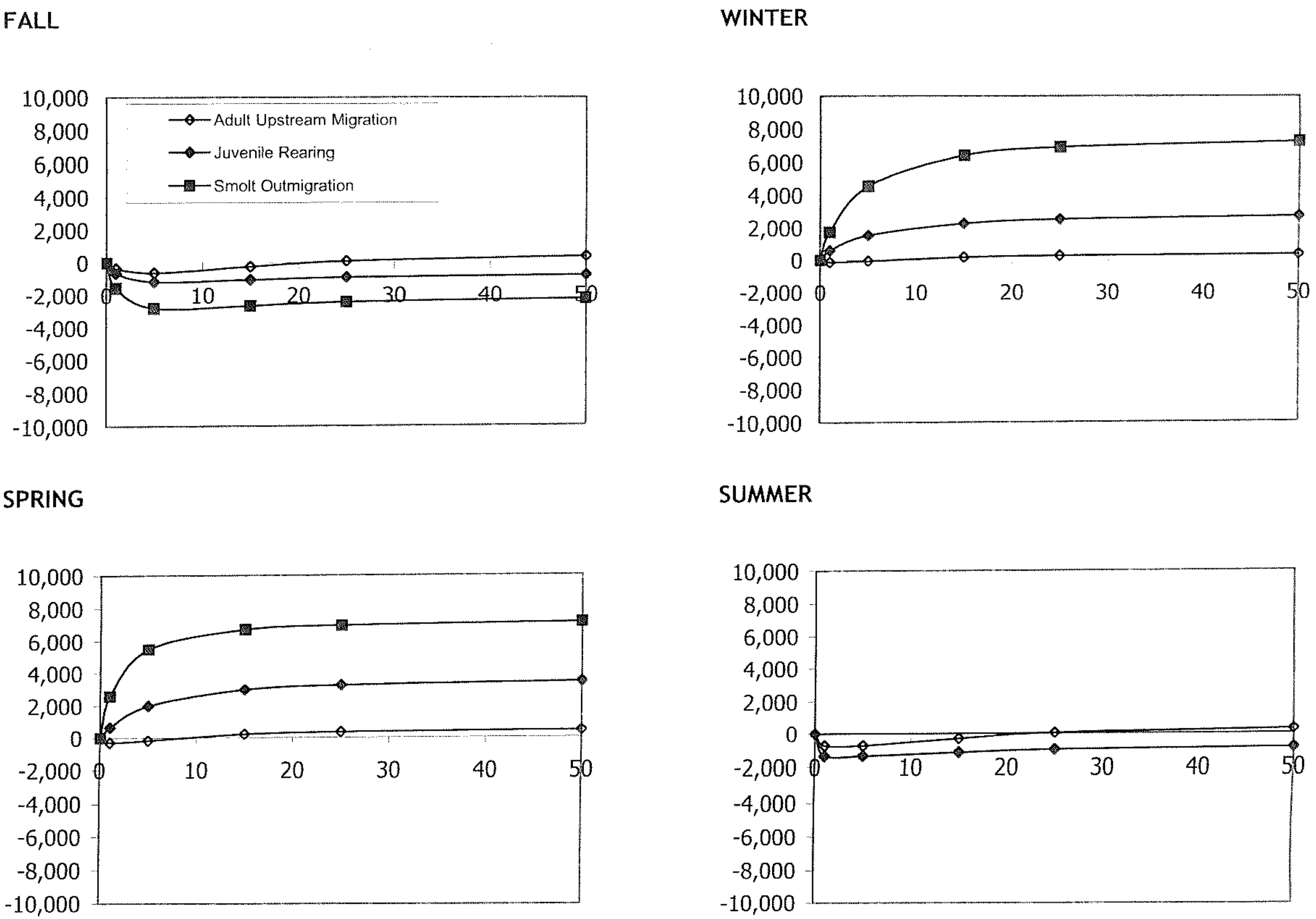

Figure 83. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 78.8L.

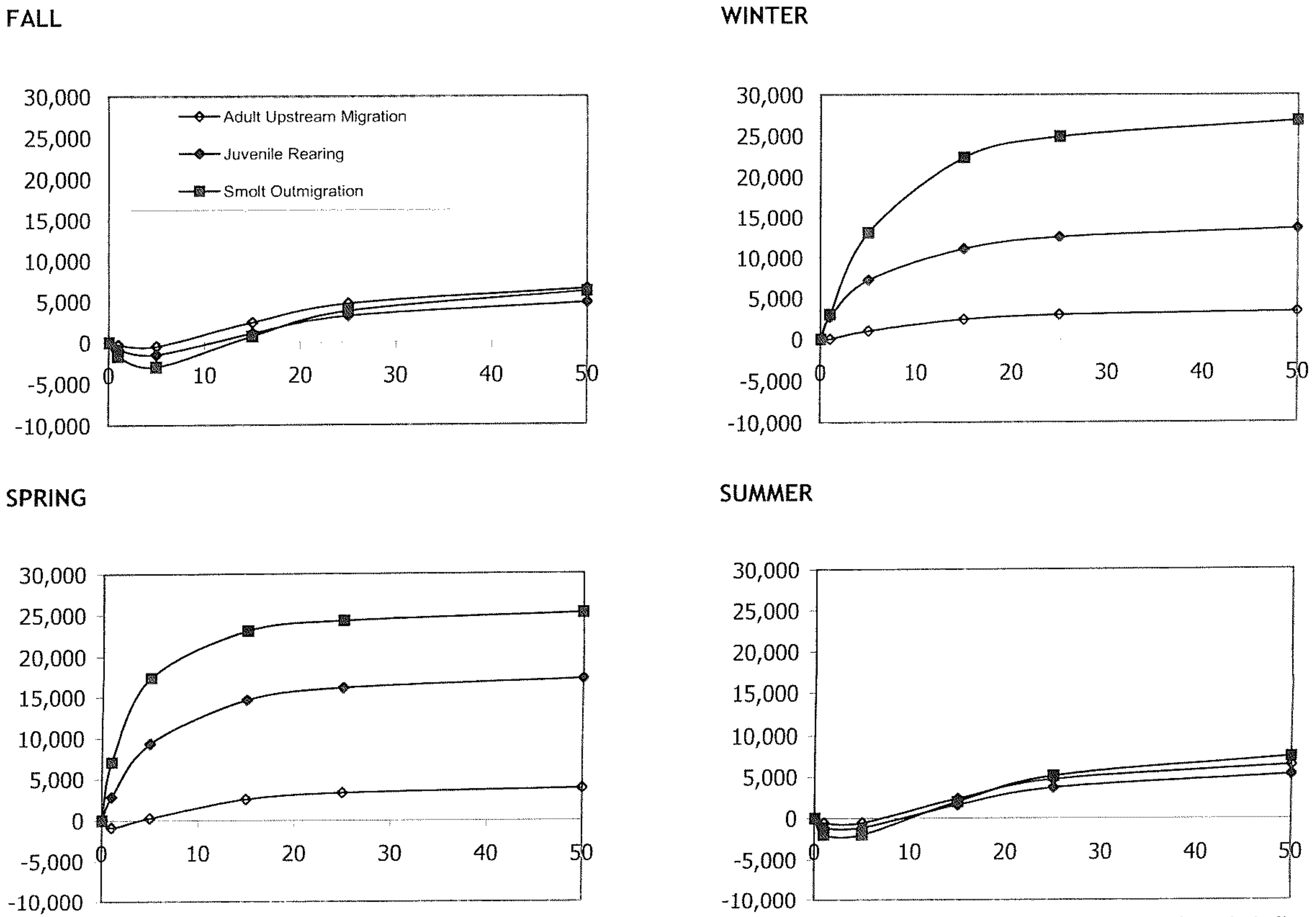

Figure 90. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Feather River RM 5.5L.

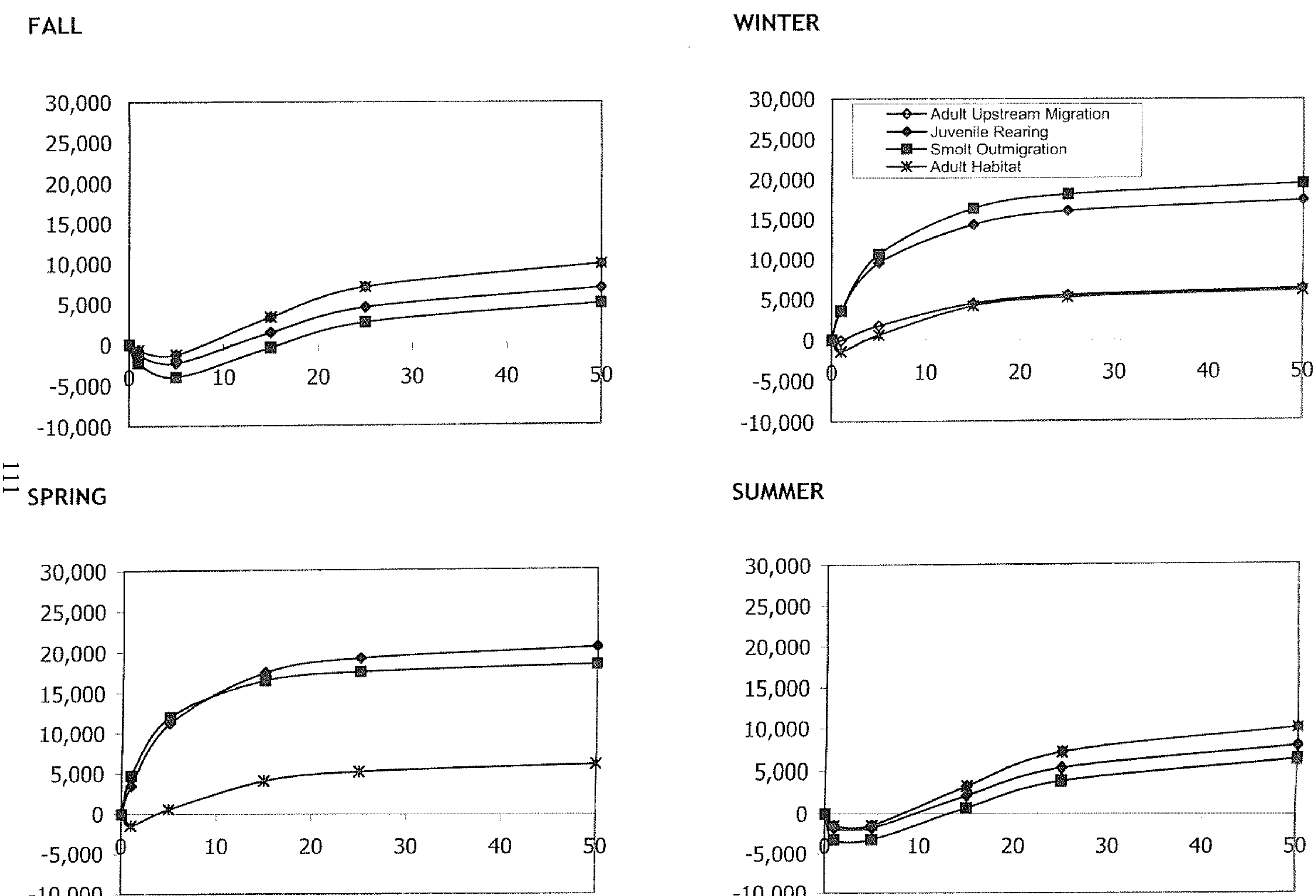

Figure 91. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Feather River RM 5.5L.

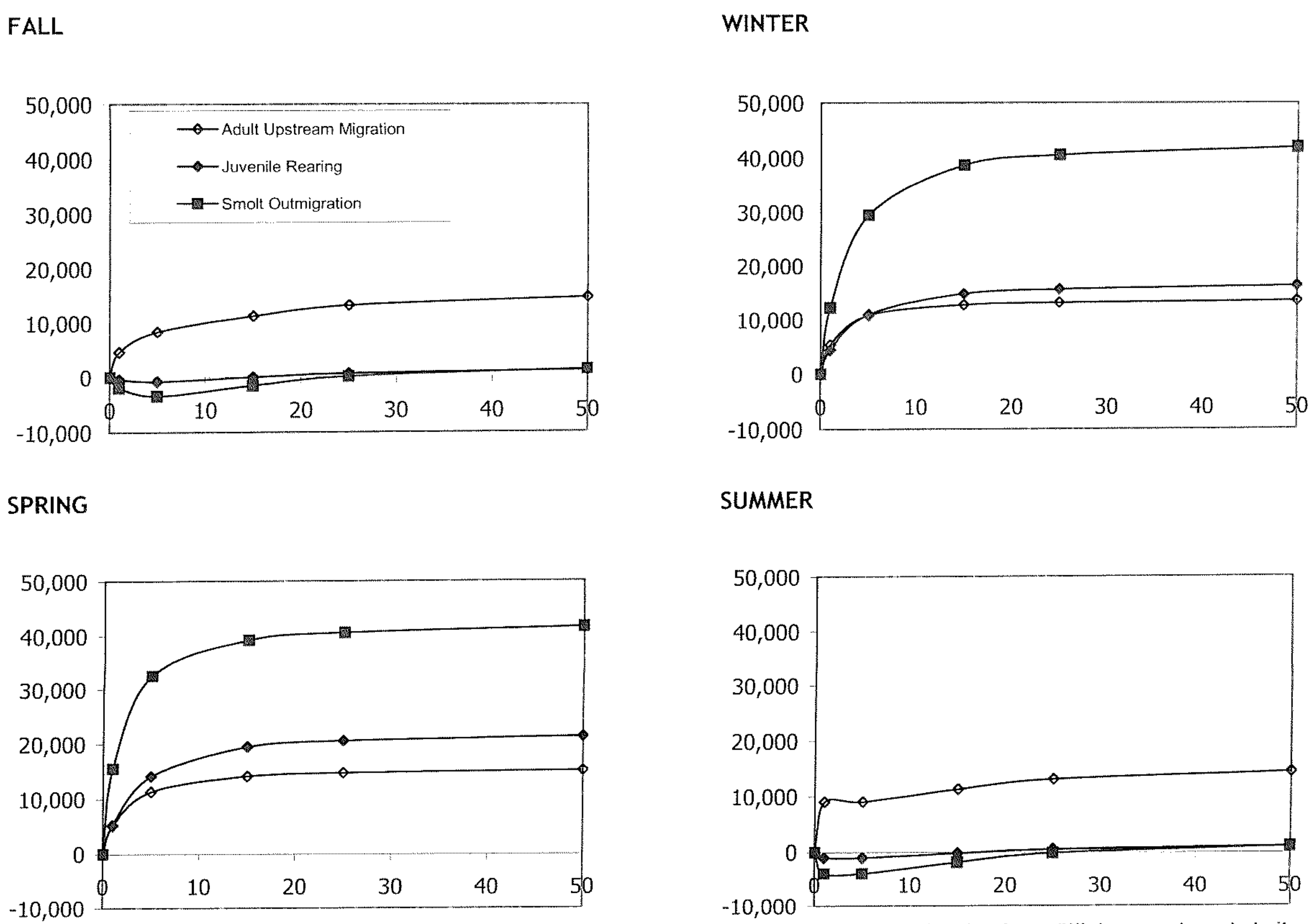

Figure 92. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Feather River RM 7.0L.

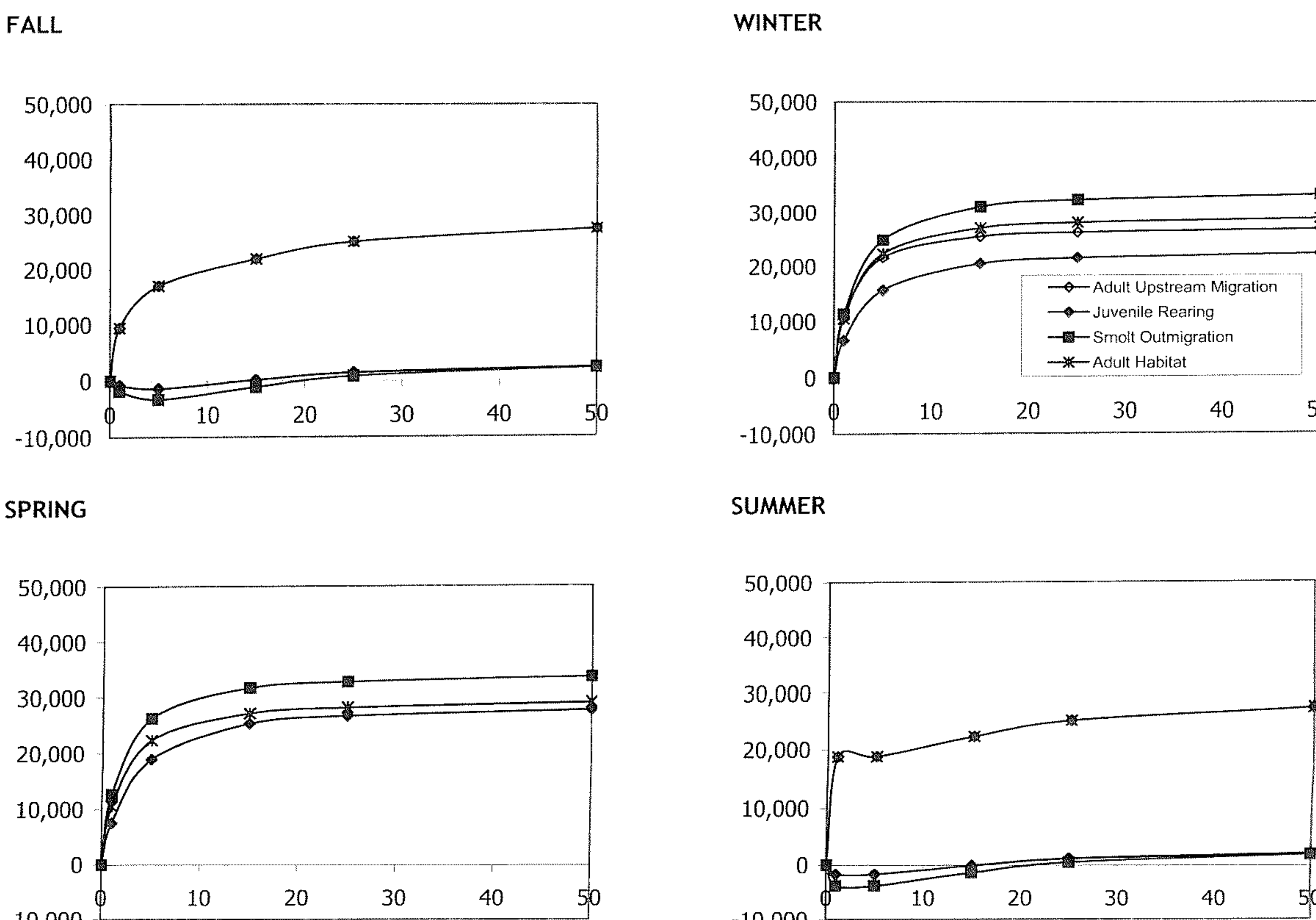

Figure 93. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Feather River RM 7.0L.

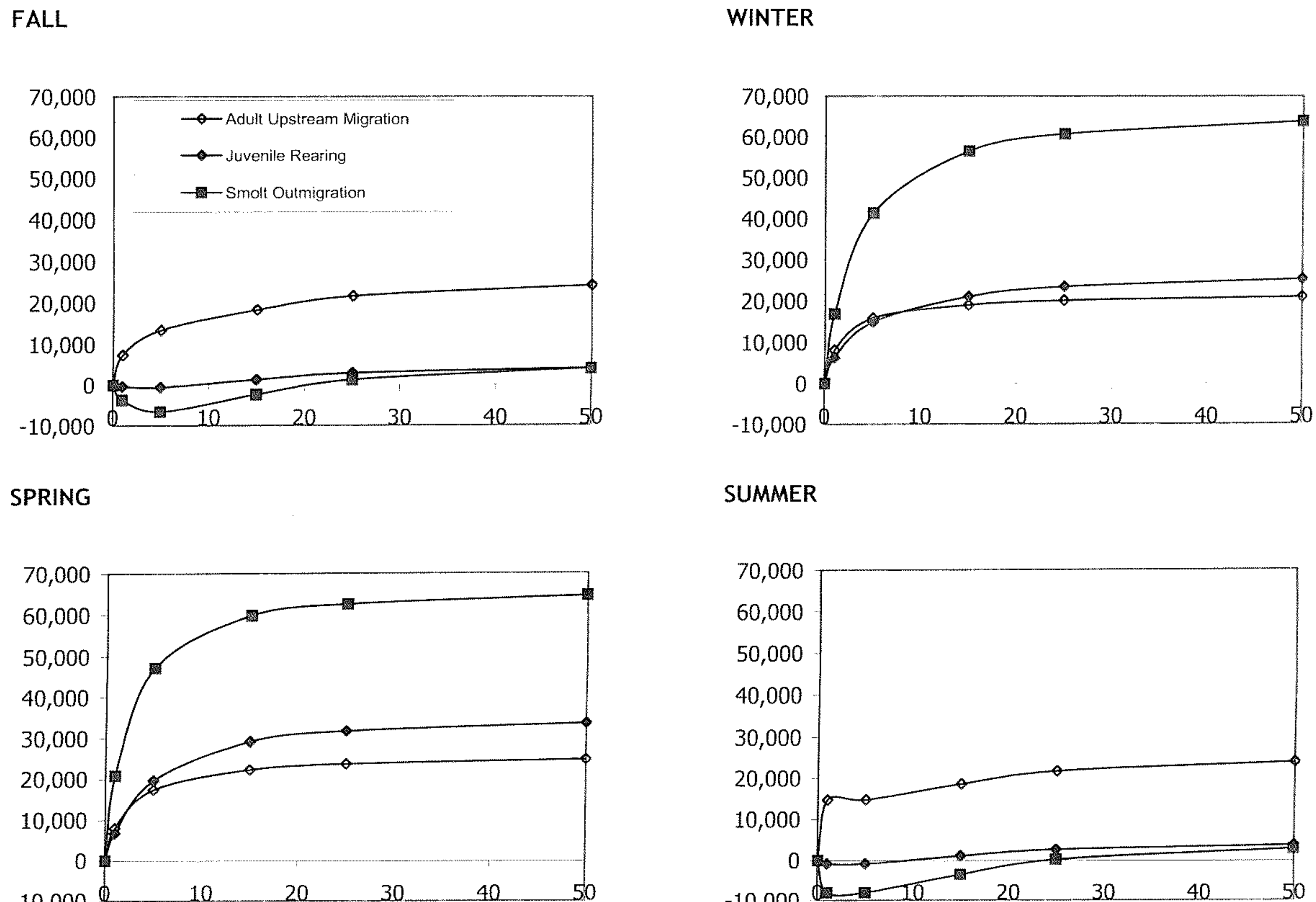

Figure 94. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 87.0L.

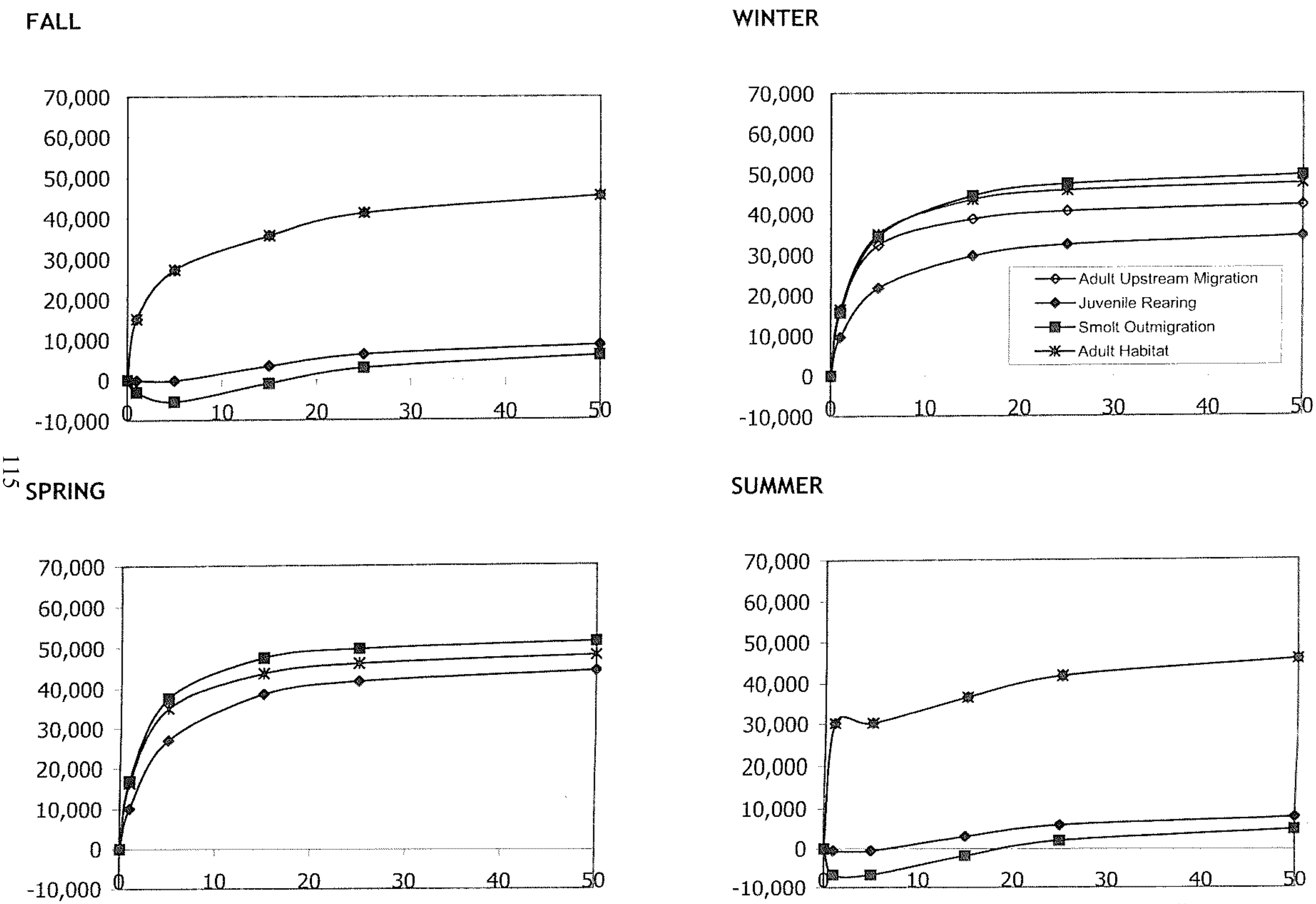

Figure 95. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 87.0L.

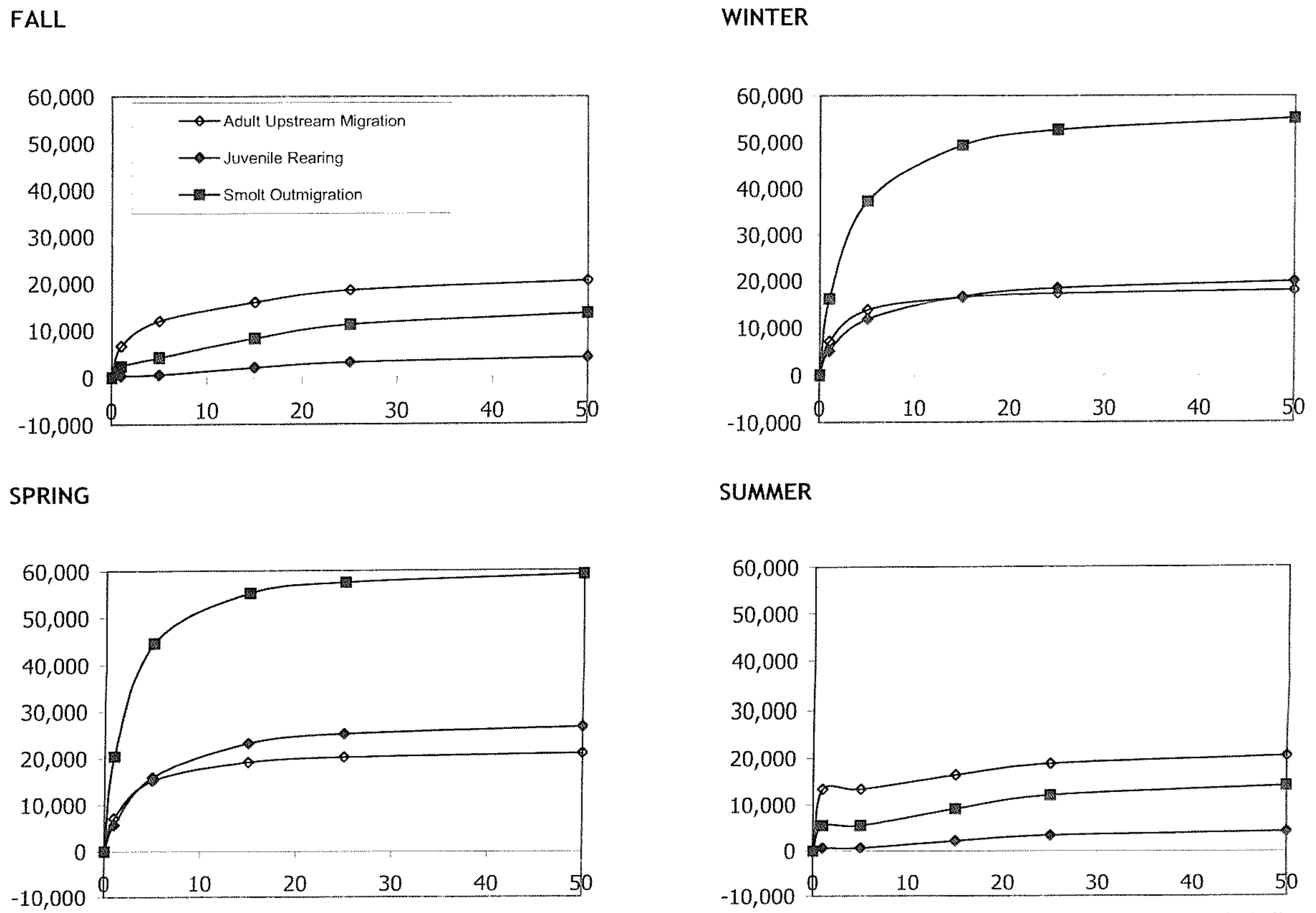

Figure 96. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 93.7L.

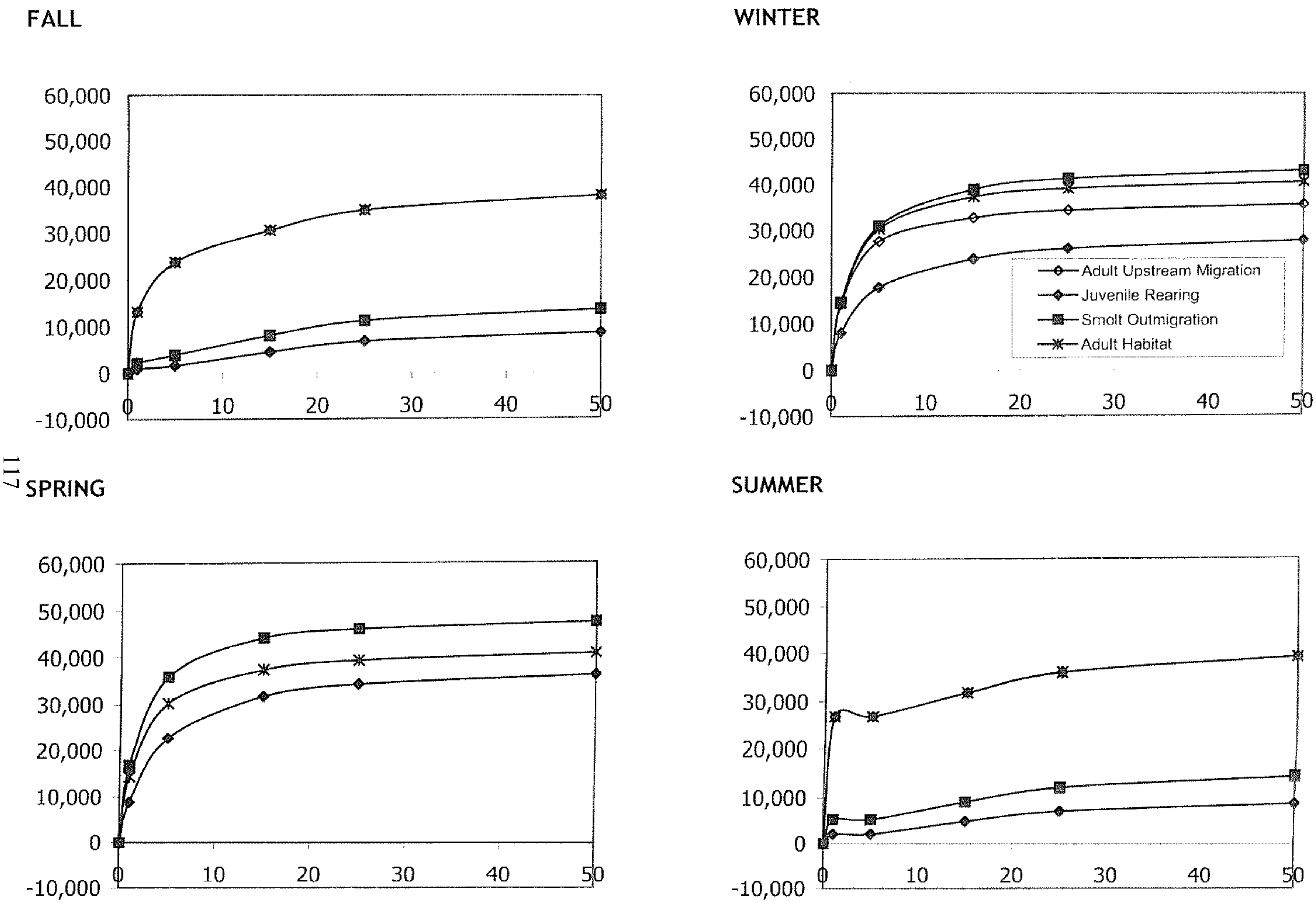

Figure 97. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 93.7L.

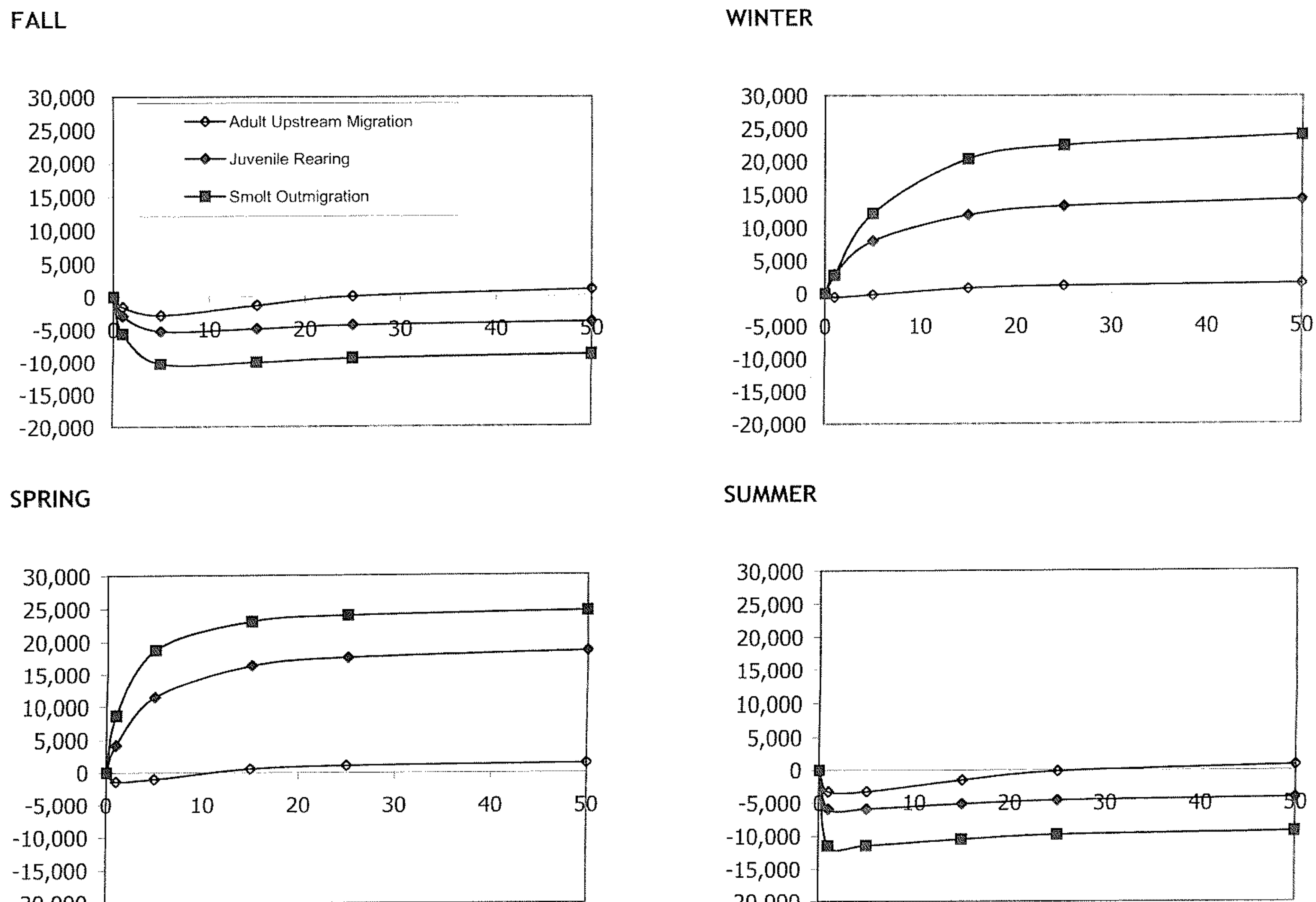

Figure 98. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 114.5R.

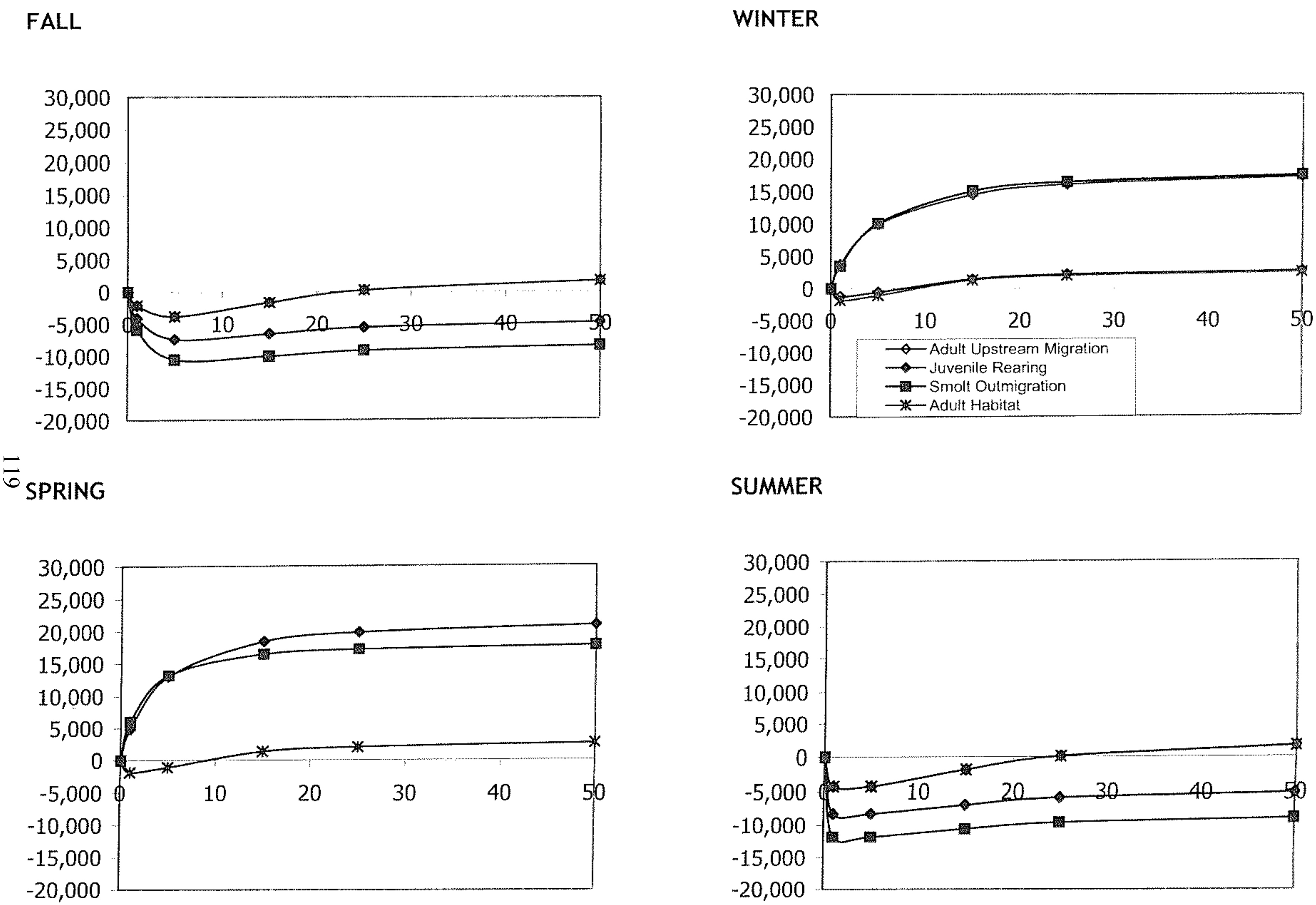

Figure 99. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 114.5R.

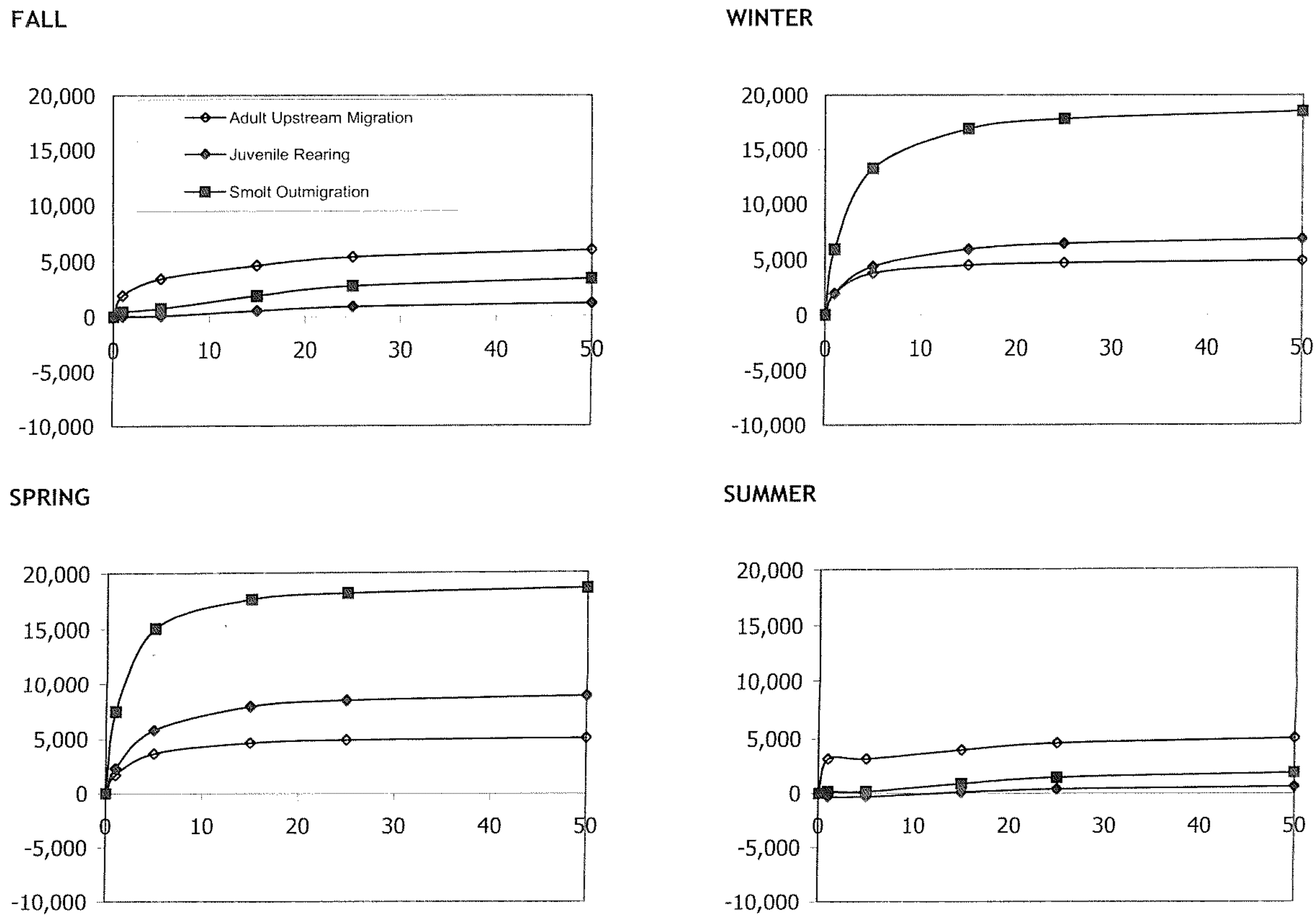

Figure 102. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 136.7R.

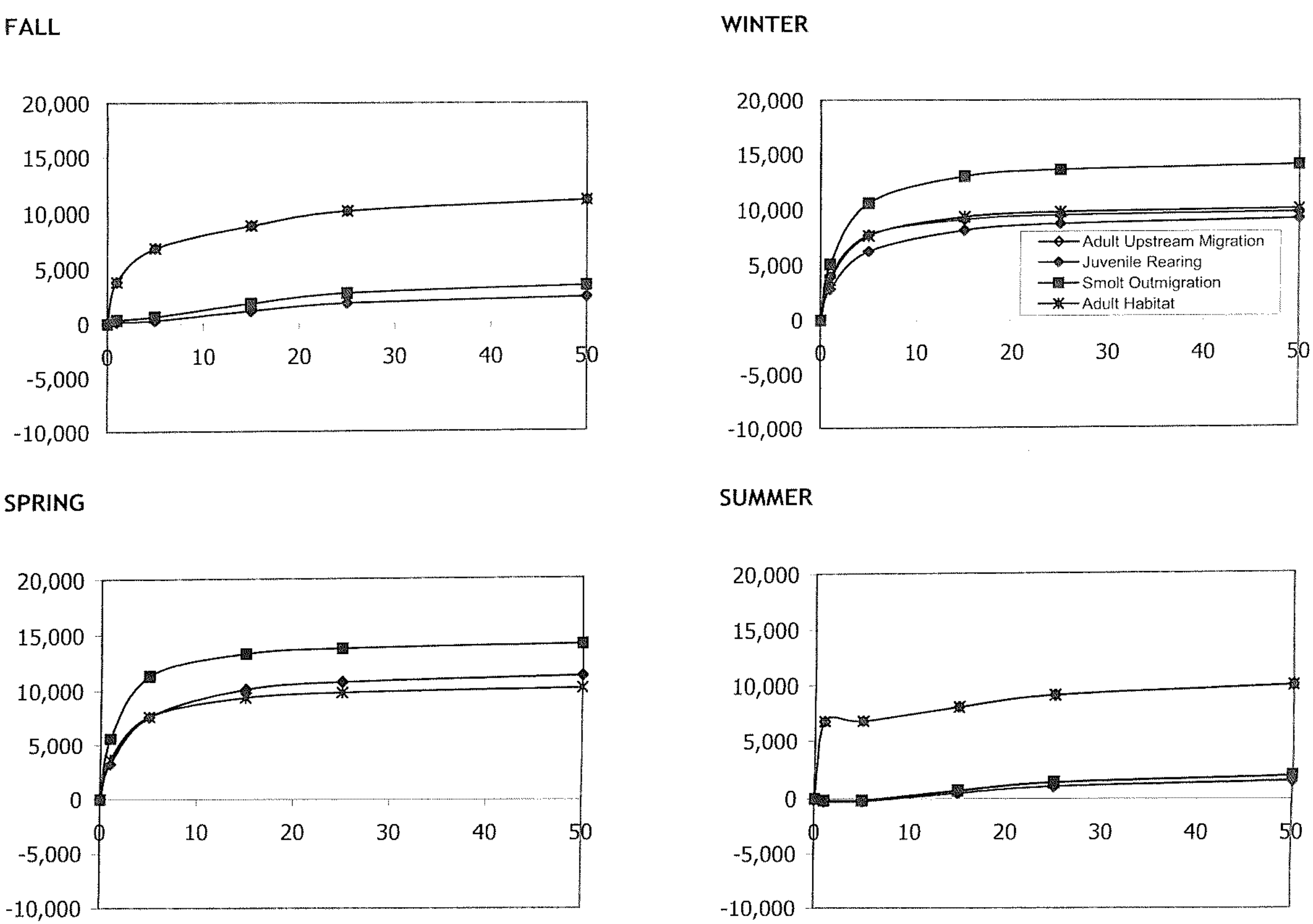

Figure 103. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 136.7R.

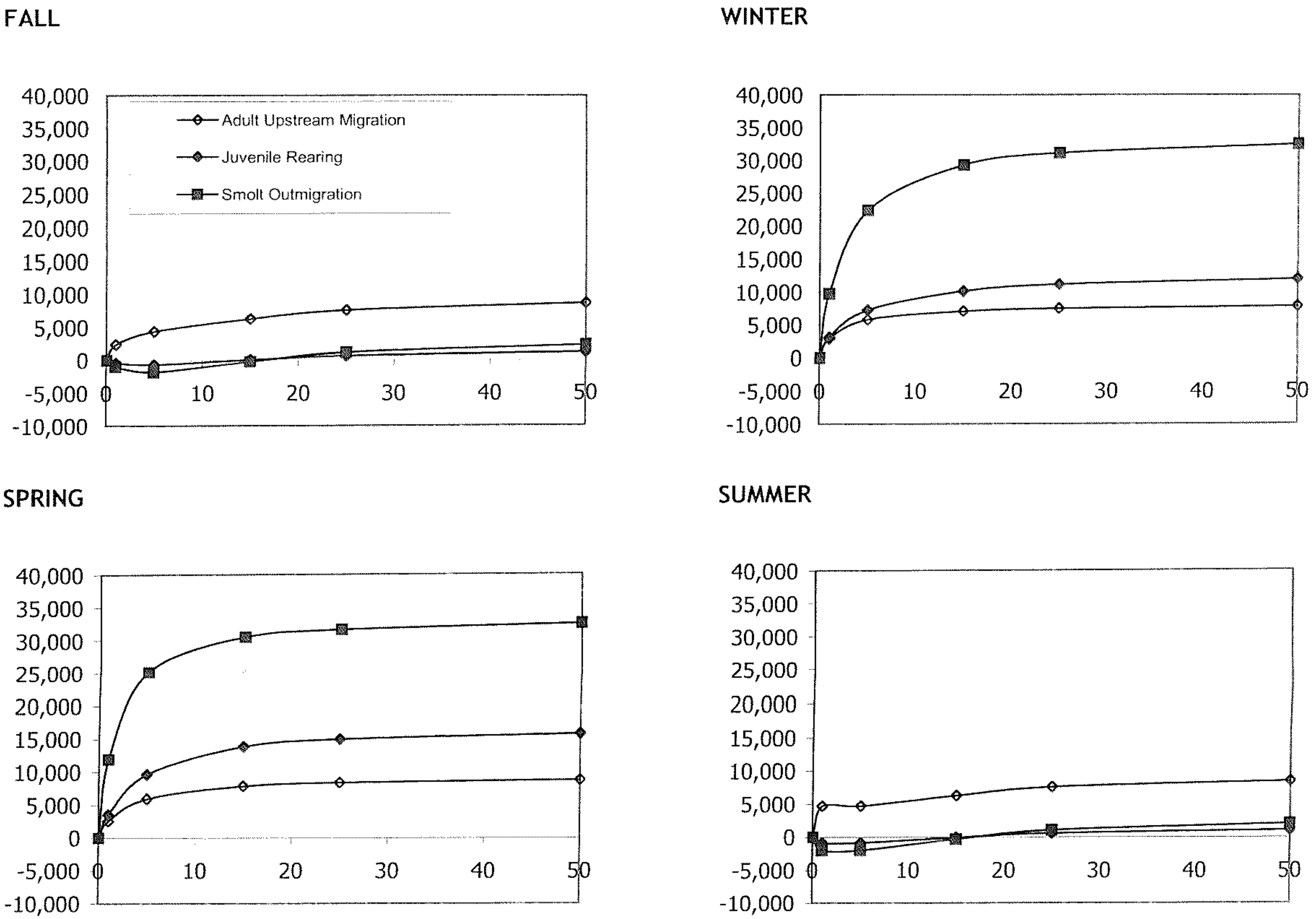

Figure 104. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sacramento River RM 136.9R.

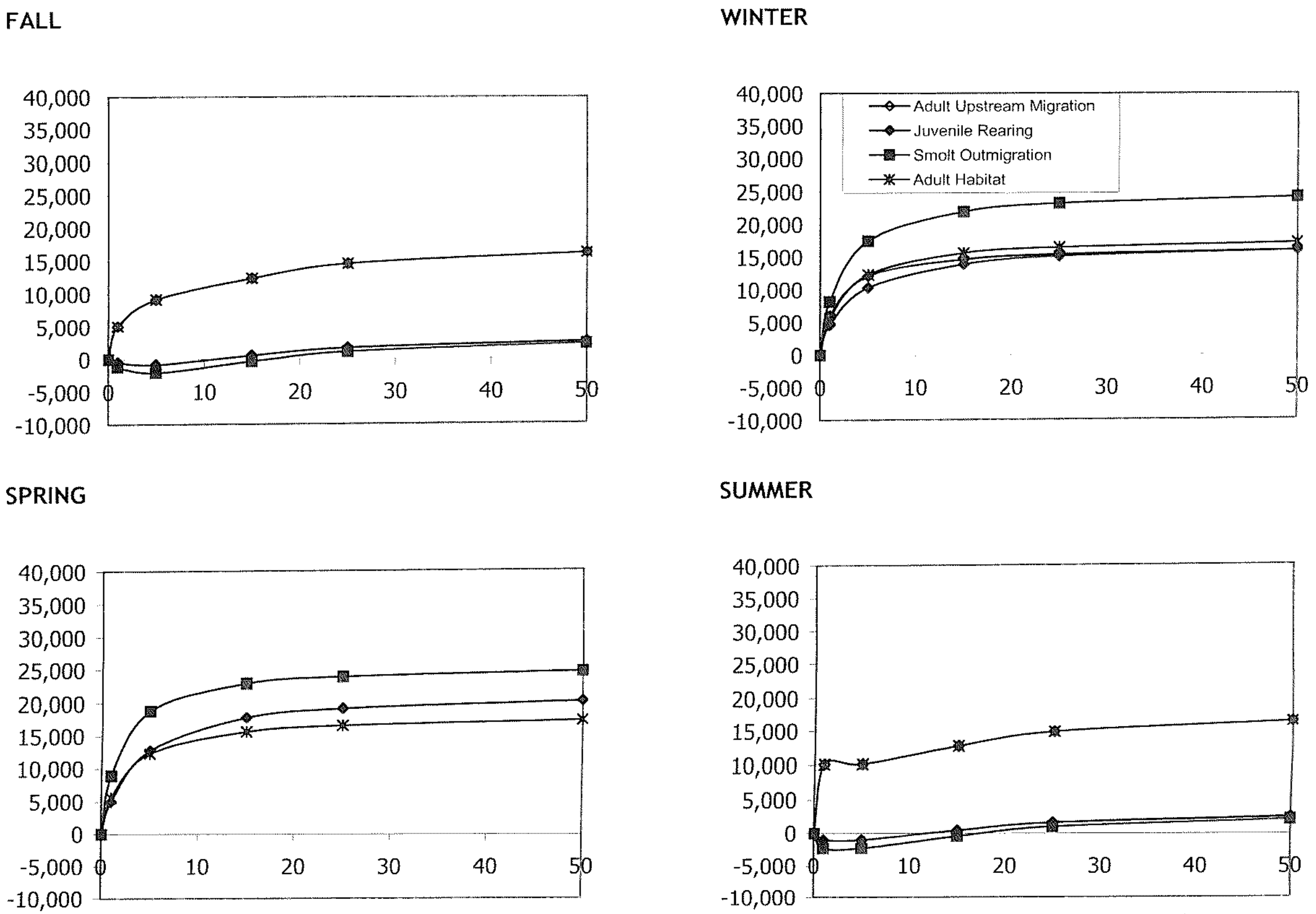

Figure 105. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sacramento River RM 136.9R.

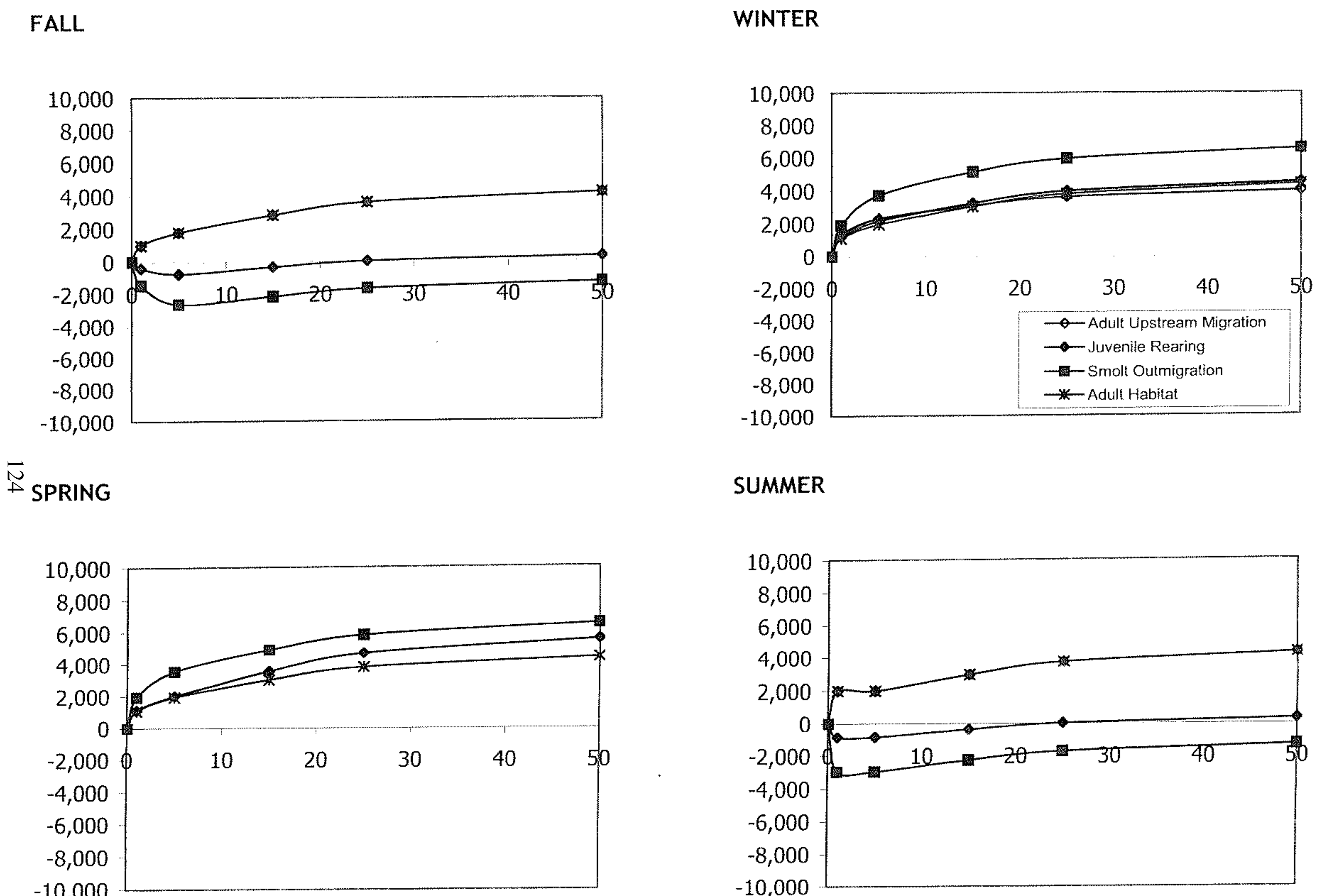

Figure 107. SAM results showing wetted-area weighted relative response (square feet) for Central Valley steelhead at site Sutter Bypass LM 0.4E.

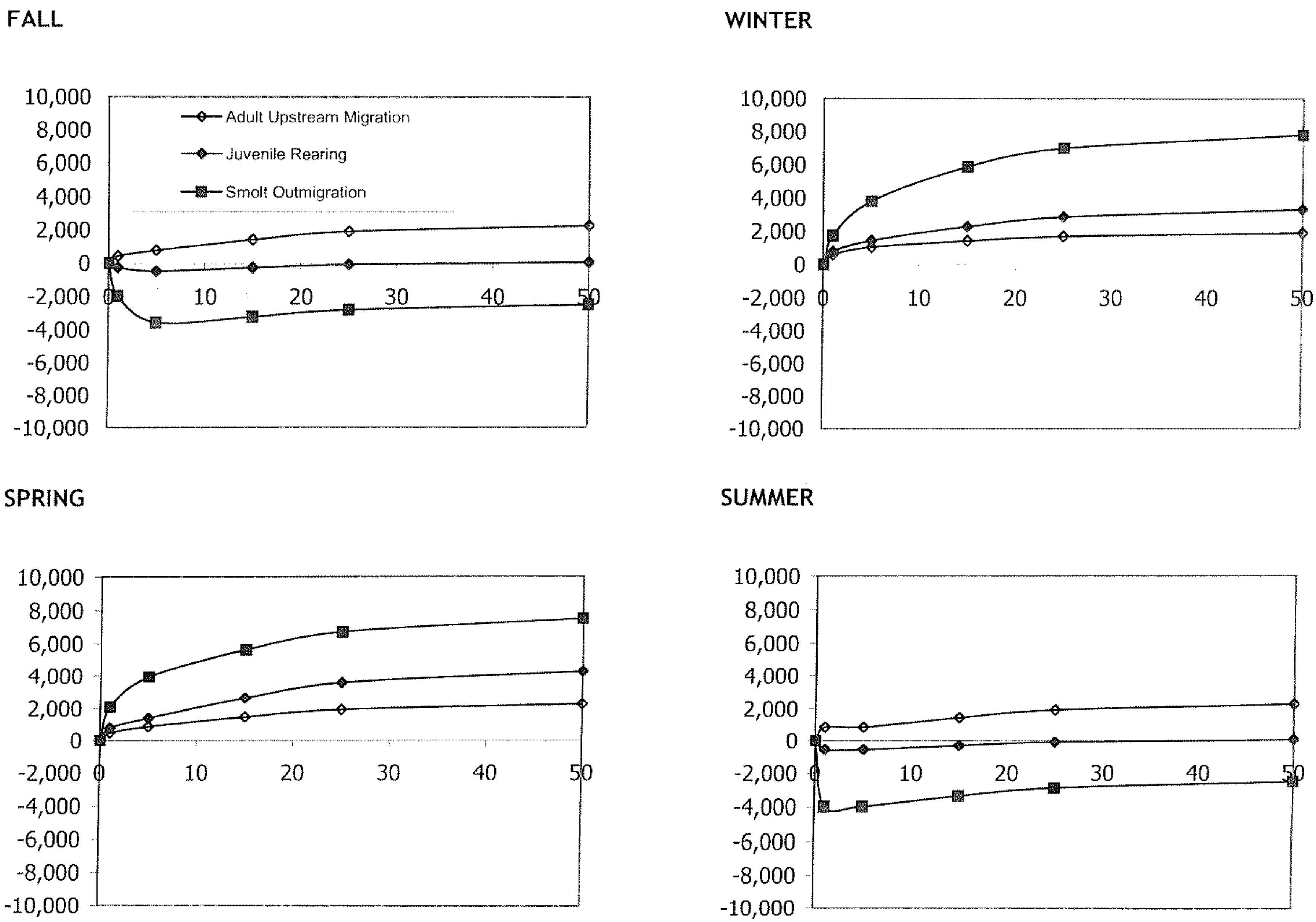

Figure 106. SAM results showing wetted-area weighted relative response (square feet) for Chinook salmon (Winter-run shown) at site Sutter Bypass LM 0.4E.

Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

ACTION AGENCY:	United States Army Corps of Engineers Sacramento District
ACTIVITY:	Addendum to the Programmatic Consultation for Phase II of the Sacramento River Bank Protection Project for Twelve Levee Repair Projects in the Sacramento River Flood Control Project
CONSULTATION CONDUCTED BY:	NOAA's National Marine Fisheries Service, Southwest Region
FILE NUMBER:	151422SWR2009SA00195
DATE ISSUED:	JUL 27 2009

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

This document represents the National Marine Fisheries Service's (NMFS) Essential Fish Habitat (EFH) consultation based on our review of a supplemental project description and effects analysis for the repair of 12 levee erosion sites within the Sacramento River Flood Control Project for the U.S. Army Corps of Engineers (Corps) 24,000 linear feet of authority under Phase II of the Sacramento River Bank Protection Project (SRBPP). The Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (U.S.C 180 et seq.) requires that EFH be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NMFS on activities which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies. The geographic extent of freshwater EFH for Pacific salmon in the Sacramento River includes waters currently or historically accessible to salmon within the action area described in the programmatic biological opinion for the remaining 24,000 linear feet of authority under Phase II of the SRBPP (NMFS 2008).

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

The programmatic biological opinion for the remaining 24,000 linear feet of authority under Phase II of the SRBPP (NMFS 2008), and the addendum to that opinion, which analyzes the specific proposal to construct 12 levee repairs, address Chinook salmon listed under the both the Endangered Species Act (ESA) and the MSA that potentially will be affected by the proposed action. These salmon include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon (*O. tshawytscha*)). This EFH consultation will concentrate on Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) because they are covered under the MSA but not listed under the ESA.

Historically, Central Valley fall-run Chinook salmon generally spawned in the Central Valley and lower-foothill reaches up to an elevation of approximately 1,000 feet. Much of the historical fall-run spawning habitat was located below existing dam sites and the run therefore was not as severely affected by water projects as other runs in the Central Valley.

Although fall-run Chinook salmon abundance is relatively high, several factors continue to affect habitat conditions in the Sacramento River, including loss of fish to unscreened agricultural diversions, predation by warm-water fish species, lack of rearing habitat, regulated river flows, high water temperatures, and reversed flows in the Delta that draw juveniles into State and Federal water project pumps.

A. Life History and Habitat Requirements

Central Valley fall-run Chinook salmon enter the Sacramento River from July through December, and late fall-run enter between October and March. Fall-run Chinook salmon generally spawn from October through December, and late fall-run fish spawn from January to April. The physical characteristics of Chinook salmon spawning beds vary considerably. Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that the there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less that 5 percent fines (Reiser and Bjornn 1979).

Fall-run Chinook salmon eggs incubate between October and March, and juvenile rearing and smolt emigration occur from January through June (Reynolds *et al.* 1993). Shortly after emergence, most fry disperse downstream towards the Sacramento-San Joaquin Delta and estuary while finding refuge in shallow waters with bank cover formed by tree roots, logs, and submerged or overhead vegetation (Kjelson *et al.* 1982). These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

II. PROPOSED ACTION.

The Corps proposes to construct 12 levee repair sites in the SRBPP, totaling nearly 10,000 linear feet of shoreline EFH. The SRBPP is a continuing construction project, authorized by the Flood Control Act of 1960, to provide protection for the existing levees and flood control facilities of the Sacramento River Flood Control Project (SRFCP). The purpose of the action is to ensure the reliability of the levees of the SRFCP for the life of the project, while protecting environmental values and compensating and/or mitigating effects on environmental resources to the degree feasible. The SRFCP consists of approximately 980 miles of levees plus overflow weirs, pumping plants, and bypass channels that protect communities and agricultural lands in the Sacramento Valley and Sacramento-San Joaquin Delta (Delta). A vicinity map illustrates this area in Figure 1.

The action is the repair of waterside levee-bank erosion sites that occur within the SRBPP project area, which includes the Sacramento River from the town of Collinsville, at river mile (RM) 0 upstream to Chico at RM 194. The SRBPP also includes reaches of lower Elder and Deer creeks, Cache Creek, the lower reaches of the American River (RM 0–23), Feather River (RM 0–61), Yuba River (RM 0–11), and Bear River (RM 0–17), and portions of Threemile, Steamboat, Sutter, Miner, Georgiana, and Cache sloughs. A detailed description of the proposed action is provided in the *Description of the Proposed Action* section of the preceding biological opinion (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on Pacific Coast salmon EFH would be similar to those discussed in the *Effects of the Proposed Action* section of the preceding addendum to the programmatic biological opinion (Enclosure 1, NMFS 2008) for endangered Sacramento River winter-run Chinook salmon, threatened CV spring-run Chinook salmon, and threatened Central Valley steelhead. A summary of the effects of the proposed action on Central Valley fall-/late fall-run Chinook salmon is provided below.

Adverse effects to Chinook salmon habitat will result from construction related impacts, operations and maintenance impacts, and long-term impacts related to modification of aquatic and riparian habitat throughout the action area. Primary construction related impacts include riprapping approximately 10,000 lf of riverbank. Integrated conservation measures to minimize adverse effects of riprapping will be applied to all sites. Conservation measures include construction of seasonally inundated terraces that will be planted with riparian vegetation. IWM will be placed both below and above the mean summer water surface elevation to provide habitat complexity, refugia, and food production of juvenile Chinook salmon. Offsite conservation measures, including setback levees, IWM installation, and shallow-bank construction will be implemented to compensate for temporal and spatial effects of individual future actions.

In-channel construction activities such as vegetation removal, grouting, and rock placement will cause increased levels of turbidity. Turbidity will be minimized by implementing the proposed conservation measures such as implementation of standard in-river construction “best management practices" (BMPs) and adherence to Regional Water Quality Control Board water quality standards. Fuel spills or use of toxic compounds during project construction could release toxic contaminants into the Sacramento River. Adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak.

The effects of O&M actions will be similar to construction impacts. The Corps expects to place no more than 600 tons of rock annually. Most actions are expected to occur during the summer when anadromous fish are not expected to be present. Additionally, since O&M actions will not occur every year, and actions will be specific and localized in nature, O&M impacts will be smaller and shorter in duration.

At some sites, there will be short and long-term losses of habitat value. Long-term impacts are expected to adversely affect EFH for adult salmon at all seasonal water surface elevations for 2 to 12 years. Impacts at the fall and summer water surface elevation are expected to be the most substantial due to the inherent difficulties of re-establishing riparian vegetation at these zones. Long-term effects of the project (*i.e.*, 5 to 50 years) will be positive as riparian habitat becomes mature. Overall, the action is expected to result in a net improvement in habitat conditions essential to the survival and growth of Chinook salmon, especially at winter and spring flows when the majority of Chinook salmon are outmigrating through the action area. These measures are expected to maintain and improve the conservation value of the habitat for Chinook salmon and avoid habitat fragmentation that typically is associated with riprapping.

IV. CONCLUSION

Upon review of the effects of the proposed action NMFS believes that the project will result in adverse effects to the EFH of Pacific salmon protected under the MSA.

V. EFH CONSERVATION RECOMMENDATIONS

Considering that the habitat requirements of fall-run Chinook salmon within the action area are similar to the requirements of Federally listed species addressed in the preceding addendum to the programmatic biological opinion (Enclosure 1), NMFS recommends that the Terms and Condition, and the Conservation Recommendations in the preceding biological opinion prepared for the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and Central Valley steelhead be adopted as EFF Conservation Recommendations.

Section 305(b)4(B) of the MSA requires the Corps to provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR ' 600.920(j)). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

VI. LITERATURE CITED

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